DENHAM VALLEY

CONSERVATION REPORT

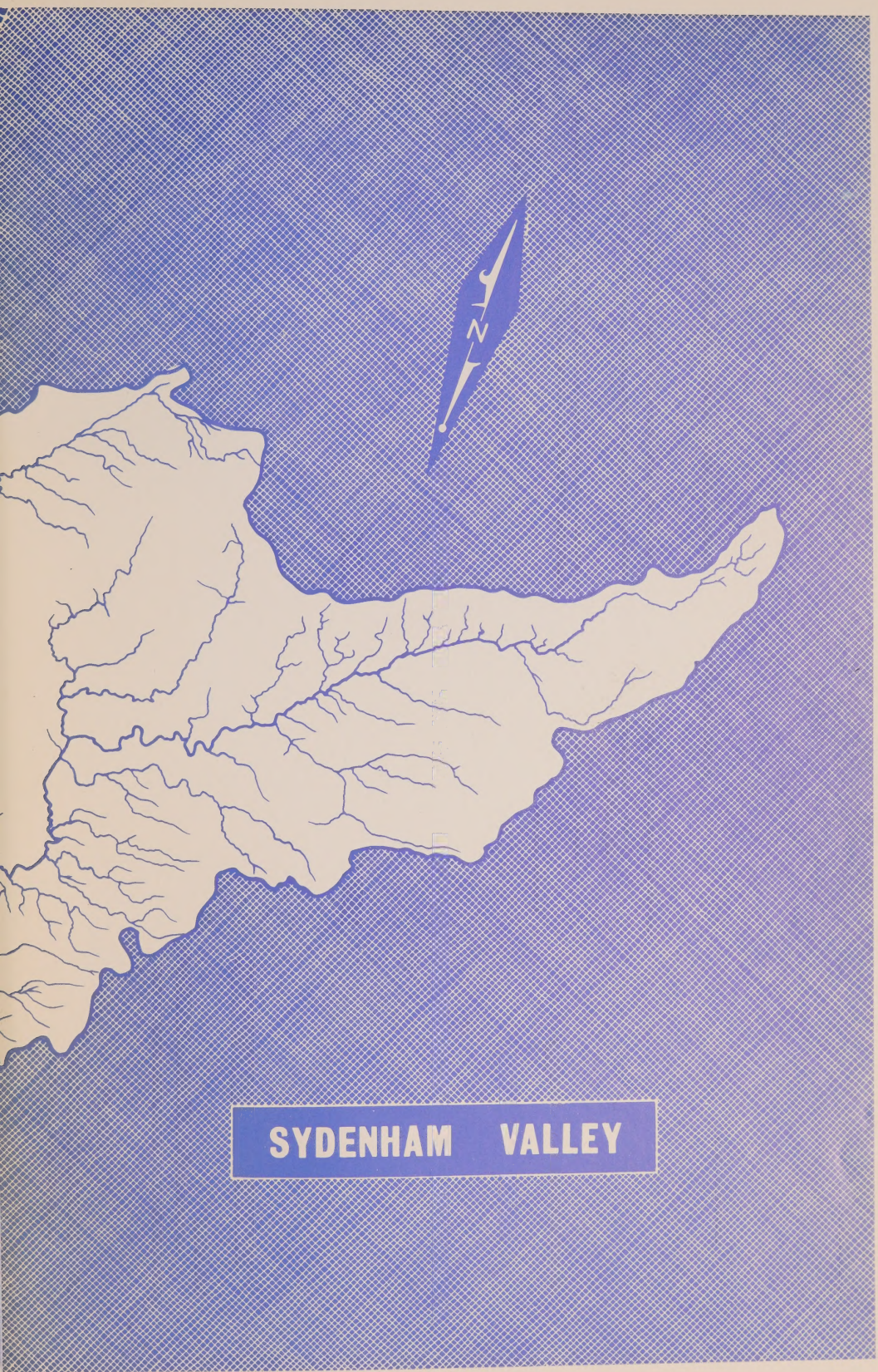
1968

SUMMARY

ONTARIO

Department of Energy and Resources Management


LAKE HURON
ST. CLAIR RIVER
LAKE ST CLAIR


N
SYDENHAM VALLEY

Department of Energy and Resources Management

HONOURABLE GEORGE A. KERR, *Minister* J. C. THATCHER, *Deputy Minister*

A. S. L. BARNES, *Director, Conservation Authorities Branch*

SYDENHAM VALLEY CONSERVATION REPORT 1968

SUMMARY

ONTARIO

INTRODUCTION

During the year 1967, we heard a great deal about Man the Explorer, Man the Producer and Man the Provider, but practically nothing about Man the Conservator. The role of man for the next hundred years must be that of Man the Conservator if he is to survive on this planet.

In Ontario we have had a few conservators in the past but are still far from being able to regard man in the broad sense as a conservator in this Province. At the present time, it would be fair to say that a substantial beginning has been made.

One of the most forward-looking steps was taken by the Government of Ontario when it passed the Conservation Authorities Act in 1946. Where else would one find over 800 people dedicated to the cause of conservation who devote so much of their own time with no remuneration other than a per diem allowance and mileage for attending meetings?

The Conservation Authorities Act was passed with three basic ideas in mind:

1. That the watershed is the best unit area on which to co-ordinate conservation work;
2. That the initiative for the establishment of a Conservation Authority must come from the local people; and
3. That the Government of Ontario will provide technical assistance and substantial grants to conservation authorities.

Since 1946, 38 authorities have been established, 33 in Southern Ontario and five in Northern Ontario. These embrace 563 municipalities and have jurisdiction over an area of 28,937 square miles. In other words, 4,500,000 people or 75 per cent of the total population of the Province live in watersheds covered by authorities. It is anticipated that before long conservation authorities will be established over the whole of Southern Ontario.

In order to establish an authority, the councils of two or more municipalities lying wholly or partly within a watershed must petition the Minister of Energy and Resources Management to call a meeting to discuss the question of whether or not such an authority should be established. The Minister then names the time and place of meeting and advises each municipality how many representatives it is entitled to send to the meeting. A quorum for the meeting is two-thirds of all representatives who may attend. At this meeting the Director of the Conservation Authorities Branch or his representative acts as chairman and the whole question of authorities including establishment, financing, programs and specific problems is discussed in detail. If a resolution is presented by one of the municipalities requesting the Minister to establish an authority, the resolution is voted on and requires a two-thirds majority vote of representatives present to pass. If it passes, then all municipalities in the watershed become members and the authority is established by order-in-council.

The Sydenham Valley Conservation Authority, which comprises an area of 1,052 square miles, was established January 12, 1961.

The first meeting of the authority is called by the Minister and the Director of the Branch acts as chairman until the representatives of the municipalities elect their own chairman and vice-chairman from among themselves. Then an executive committee may be elected, advisory boards set up and a tentative program outlined.

One of the first services provided by the Branch to each authority is the preparation of an overall conservation report with recommendations based on field surveys covering water, land, forests, wildlife, recreation and history. This is designed to serve as a guide to the authority in developing its conservation program for the whole watershed.

The responsibility for initiating all projects lies with the conservation authority but the authority may obtain a very considerable amount of assistance from the various departments of government, namely, grants and technical help from the Department of Energy and Resources Management, and advice in specialized fields. A resources manager, who is a member of the staff of the Department, has been seconded to the authority to advise the authority and carry out its field program.

In 1965, the Conservation Authorities Branch issued a comprehensive Report, based on resource surveys and other investigations of the Sydenham Valley watershed. This Summary has been prepared for popular distribution; although much of the original Report's technical content has been omitted, it is hoped that residents of the watershed will find this an informative and interesting publication.

A. S. L. Barnes,
Director,
Conservation Authorities Branch,
Department of Energy and
Resources Management.

AUTHORSHIP

This report was prepared under the direction of the staff of the Conservation Authorities Branch. For the Recreation section, the field work and the original draft of the report were undertaken by Professor A. J. O. Farina as consultant to the Branch.

SYDENHAM
VALLEY CONSERVATION AUTHORITY

Established January 12, 1961

Chairman	K. H. McCormick
Vice-Chairman	Lloyd Galbraith
Secretary-Treasurer	Charles J. McEwen
Resources Manager	John F. King

MEMBERS:

Adelaide Township	EUGENE W. EARLEY
Alvinston Village	J. EDMUND BORROWMAN
Bothwell Town	J. H. SMITH
Brooke Township	J. D. McGUGAN
Camden Township	ROBERT BUTLER
Caradoc Township	RUSSELL SQUIRE
Chatham Township	CRAWFORD LANGSTAFF
Dawn Township	DON WILLIAMS
Dover Township	MALCOLM CRAWFORD
Dresden Town	ED ST. PIERRE
Ekfrid Township	*LLOYD GALBRAITH
Enniskillen Township	WILLARD HALL
Euphemia Township	STARR MACAULAY
Lobo Township	WILFRED CULVER
London Township	HARRY WARD
Metcalfe Township	*GORDON MACINTYRE
Moore Township	*CHARLES YOUNG
Mosa Township	ARCHIE CAMPBELL
Newbury Village	J. D. McNAUGHTON
Oil Springs Village	W. S. ATKIN
Petrolia Town	B. E. STARK
Plymton Township	J. F. KING
Sombra Township	GORDON BRANTON
Strathroy Town	BERNARD JORDAN
Wallaceburg Town	*A. R. PERCHALUK
Wallaceburg Town	LLOYD BABCOCK
Warwick Township	JOHN PEDDEN
Watford Village	JACK ROGERS
Wyoming Village	*K. H. McCORMICK
Zone Township	GERALD HERBERT

**Member of Executive Committee.*

ACKNOWLEDGEMENTS

The Branch is indebted to numerous private citizens, Authority members and local municipal officials who provided information from first-hand experience with problems related to the Sydenham River and its tributaries.

Acknowledgement is made of the co-operation received from the staff of the Western Agricultural Experimental Station at Ridgetown, Ontario.

The pictures of flooding made available by the Wallaceburg News, the Windsor Daily Star and Mr. F. Mann of Wallaceburg are gratefully acknowledged.

CONSERVATION AUTHORITIES BRANCH
TECHNICAL STAFF

Director:

A. S. L. BARNES, B.Sc.F., R.P.F.

Chief Engineer:

J. W. MURRAY, B.A.Sc., P.Eng.

Hydraulic Engineering:

J. Y. DING, B.S.A., M.Sc., P. Eng.
F. FISCHER-JENSSEN, B.A.Sc., P.Eng.
T. M. KURTZ, B.A.Sc., M.A.Sc., P.Eng.
M. G. LEWIS, B.A.Sc., P.Eng.
G. E. ZOELLNER, B.A.Sc., P.Eng.
D. P. PUCCINI, B.A.Sc., P.Eng.

Hydrometeorology:

D. N. McMULLEN, B.A., F.R.Met.S.
P. N. GRYNIEWSKI, B.A.Sc., M.S.A., P.Eng.

Executive Assistant:

F. G. JACKSON, B.Sc.F., R.P.F.

Forestry and Land Use:

P. M. R. HARVIE, B.Sc.F., R.P.F.

History:

M. B. ADDINALL, B.A.

Recreation:

G. D. BOGGS, B.A., M.A.

Wildlife:

K. M. MAYALL, B.Sc.F., M.A., R.P.F.

Urban and Regional Planning:

V. W. RUDIK, B.A., M.T.P.I.C.

Field Services:

A. D. LATORNELL, B.S.A., M.S., P.Ag.
I. H. JENNINGS, B.Sc.F., M.A.

Authority Resource Manager:

JOHN F. KING, B.Sc.F., R.P.F.

CONTENTS

I LAND

II FORESTRY

III WATER

IV RECREATION

Recommendations

STATED OR IMPLIED IN THIS REPORT

Land

1. That the Authority publicize its program of technical and financial assistance for the building of farm ponds.
2. That on certain small areas of steeper land along gullies of the tributary system where reforestation is not an effective control measure for erosion, the Authority undertake other methods of erosion control — vegetative and mechanical.
3. That where it fits into the overall development program of Authority properties, the Authority demonstrate improved pasture management, grass waterways, windbreaks and other examples of good land use.
4. That the Authority assist county agricultural organizations and the Department of Agriculture and Food in sponsoring land-judging competitions in each county in the watershed.

Forest

1. That a Sydenham Valley Authority Forest be established and that it be expanded through a definite program of annual additions and planting until as much as is feasible is acquired and reforested of the 8,577 acres of land mapped as suitable for this purpose.
2. That the Authority encourage private reforestation by providing planting service at nominal cost in the areas described, and by offering a planting subsidy for trees privately planted. Particular emphasis should be given to bank areas of the gully system of the watershed.
3. That the Authority encourage private owners in thinnings and improvement cuttings in their woodlots by: investigating any possible markets for low-grade material, and, if found feasible, by purchasing equipment, organizing cutting crews, or by direct subsidy.
4. That the Authority investigate, publicize and urge the implementation of the best methods of protecting woodland from grazing, fire, insects and disease.
5. That the Authority co-operate with schools, government departments, and all other groups and agencies possible, to publicize the need and methods of reforestation and woodlot management; and, in particular, that the Authority sponsor tours, practical demonstrations and field days for this purpose, particularly in those woodlots and plantations that are being well managed by their owners.
6. That the Authority, to help private woodlot owners, encourage and co-operate in research to find improved methods of managing plantations and natural woodlots, and publicize the results.
7. That the Authority establish its own research project on a small acreage; and that such project be designed to improve methods of establishing plantations on clay soils and on areas of hawthorn infestation.
8. That the Authority encourage landowners to convert to productive forest such parts of the watershed scrublands as cannot economically be restored

to agricultural use, or that are not acting as a natural erosion control on stream banks and the sides of gullies; and that the Authority promote and encourage efforts to improve the control of hawthorn infestation.

9. That the Authority urge the County of Kent to adopt tree cutting by-laws to prevent the indiscriminate cutting of woodlots.
10. That the Authority act as co-sponsor for the Tree Farm movement and 4-H Forestry Clubs.
11. That the Authority encourage: the further establishment of windbreaks, shelterbelts and snow fences, and investigations into the improvement of their placement and design.
12. That the Authority promote the use of cutting contracts by all parties engaged in logging on the watershed. It is further recommended that such contracts be in the form suggested in this report.
13. That the Authority encourage any marketing methods or organizations, including co-operatives, which would increase the owners' interest in better management by securing them a greater return for their woodland produce.

Water

1. That the Authority promote a program for the expansion of the present hydrometric and meteorological gauging network in the watershed and that this program be completed within a five-year period.
2. That the Authority ensure that the municipal councils of the towns of Wallaceburg and Dresden are fully aware of the flood potential and that further development in these areas be controlled to minimize this danger as much as possible.
3. That the Authority consider the immediate construction of a dam on the East Sydenham River at Alvinston immediately upstream from the Highway No. 80 crossing.
4. That the Authority consider the construction of the following additional dams and reservoirs as funds become available: Petrolia Dam and Reservoir on Bear Creek, Brigden Dam and Reservoir on Bear Creek, and Wilkesport Dam and Reservoir on Flat Creek.
5. That the Authority take the necessary action to ensure that the lands required for the recommended dam and reservoir sites are preserved for that purpose.
6. That the Authority consider for future study the possibility of constructing flood control diversions at Wallaceburg and Dresden.
7. That the Authority encourage the Town of Wallaceburg to prepare a master plan for waterfront development in order that all shoreline protective work may be carried out in accordance with the overall plan.
8. That the Authority continue its flood plain acquisition program at Strathroy and that this program be expanded to include the other municipalities where such acquisition would be desirable.
9. That an Engineering Study be made to evaluate the need for channel improvement work in Strathroy.
10. That the Authority support the Ontario Water Resources Commission in every way possible in its efforts to reduce pollution in the Sydenham River and its tributaries.

11. That the Authority co-operate with the Ontario Water Resources Commission in the development of ground-water studies and request that the Commission establish observation wells at critical points.
12. That Authority assistance for stream bank erosion control on private lands take the form of technical advice and demonstration of recommended methods.

Recreation

That the Sydenham Valley Conservation Authority consider the possibilities of developing the following areas for conservation and recreation: Duthill, Avonry, Petrolia, Alvinston, Coldstream, Oakdale and Dresden.

PART I - LAND

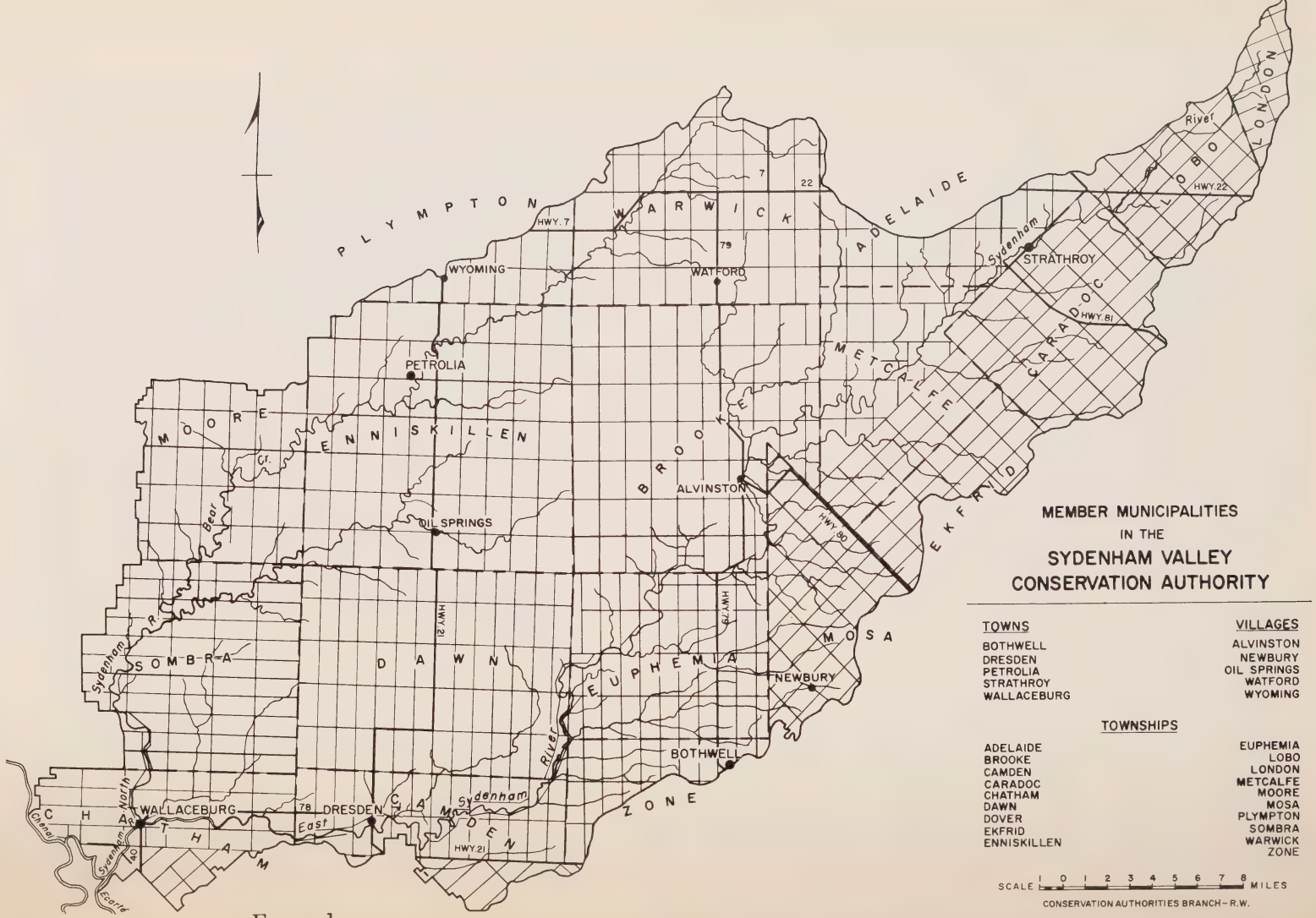

PLYMPTON
WARWICK
ADELAIDE
LOBO
LONDON
METCALFE
CARADOC
BROOKE
ENNISKILLEN
MOORE
DAWN
SOMBRA
EUPHEMIA
MOSA
EKFRID
ZONE
CHATHAM
WYOMING
WATFORD
STRATHROY
PETROLIA
OIL SPRINGS
ALVINSTON
NEWBURY
BOTHWELL
WALLACEBURG
DRESDEN
Sydenham River
Bear Cr.
North Sydenham
Chenal Ecarté
East Sydenham
HWY.7
HWY.22
HWY.81
HWY.80
HWY.21
HWY.79
7
22
79
78
40
MEMBER MUNICIPALITIES
IN THE
SYDENHAM VALLEY
CONSERVATION AUTHORITY
TOWNS
BOTHWELL
DRESDEN
PETROLIA
STRATHROY
WALLACEBURG
VILLAGES
ALVINSTON
NEWBURY
OIL SPRINGS
WATFORD
WYOMING
TOWNSHIPS
ADELAIDE
BROOKE
CAMDEN
CARADOC
CHATHAM
DAWN
DOVER
EKFRID
ENNISKILLEN
EUPHEMIA
LOBO
LONDON
METCALFE
MOORE
MOSA
PLYMPTON
SOMBRA
WARWICK
ZONE
SCALE 0 1 2 3 4 5 6 7 8 MILES
CONSERVATION AUTHORITIES BRANCH – R.W.

FIGURE 1

CHAPTER 1

INTRODUCTION

The watershed or drainage basin of the Sydenham River encompasses 1,052 square miles. About 78 per cent of the watershed lies in Lambton County with 15 per cent in Middlesex and 7 per cent in Kent.

The Sydenham Watershed is bounded on the north and north-east by the Ausable Valley and to the north-west and west by the many small streams flowing into Lake Huron and the St. Clair River. To the south and the east, drainage is into the Thames and Little Bear Creek Watersheds.

The watershed is a broad, rather featureless plain, crossed by a regular grid of township and county roads and a number of Provincial highways. These roads, together with several rail lines, serve the municipalities with direct transportation routes to the main centres of population. There are no large towns or cities in the Sydenham Watershed. The region looks to Sarnia, London, Chatham and Windsor as its commercial and industrial centres; Wallaceburg is the largest town and commercial focus of the south-western region, with Strathroy filling a similar role in the north-east. Both have agricultural processing facilities. Wallaceburg is a busy small boating town in the summer months.

The Authority has jurisdiction over an area extending into 19 townships and including five villages and five towns. These are:

The Towns of
- Wallaceburg
- Strathroy
- Petrolia
- Dresden
- Bothwell

The Villages of
- Alvinston
- Newbury
- Oil Springs
- Watford
- Wyoming

The Townships of

Adelaide	Dawn	Lobo	Plympton
Brooke	Dover	London	Sombra
Camden	Ekfrid	Metcalfe	Warwick
Caradoc	Enniskillen	Moore	Zone
Chatham	Euphemia	Mosa	

1. Hydrography

The Sydenham River drainage area is a plain of rather low relief, hence stream gradients are low. The average slope of the Sydenham from headwater to mouth is 3.3 feet per mile.

The Sydenham system has two main branches. The north branch, or Bear Creek, has its source near Arkona in the north-eastern part of Lambton County. Its valley is narrow and shallow, and does not create any prominent feature on the landscape.

The east branch rises on the Lucan moraine near Ilderton. It falls a little more rapidly than the north branch. The two branches join at Wallaceburg and empty into Chenal Ecarté, a channel on the low-lying shore of Lake St. Clair.

The shallow valley and the low gradient of the river have meant that it has been little used for water power and that some sections have been subject to flooding. The lower section, navigable for small pleasure craft, is much used for that purpose.

2. Climate

The climate of the Sydenham Watershed is modified somewhat by the surrounding Great Lakes. The prevailing winds are westerly. Rainfall increases north-eastward as the higher land falls more under the influence of Lake Huron, averaging 30 inches in the south-east and 35 inches annual rainfall in the north-east. Rainfall in the three-month period June to August averages between 8 and 9 inches. Usually, however, there is less than one inch in one or more of these months, thus reducing crop yields. Summer thunderstorms are common and are often accompanied by high winds and hail which cause damage to crops.

The first day with a mean temperature of 42°F is taken as the beginning of the growing season. The average date on which this temperature occurs is April 8 to 12 (moving from west to east through the watershed). The last average date having a 42°F mean temperature is November 1 to 5 (moving east to west). The average length of the growing season is 203 to 207 days, with an average frost-free season of 147 to 152 days. The average January temperature is 22°F and the July average is 69°F.

3. Physiography

During the past million years, Southern Ontario has been covered several times by tremendous continental ice sheets. The last of these great glaciers existed possibly as recently as 15,000 years ago. It was called the Wisconsin glacier because its effects were first studied in that state.

Nearly all the present-day topography of Ontario and, of course, of the Sydenham Watershed stems from the activity of the Wisconsin glacier.

As the great continental ice sheet moved forward it acted as a plough; pushing scraping, and grinding the underlying bedrock and surface deposits. The resultant material is a conglomerated heterogeneous material called *till.*

During the lengthy advances there were times of minor recessions in the glaciers caused, probably, by warmer weather leading to the melting of the ice. Vast quantities of meltwaters poured forth from the glacier, streaming into glacial lakes. These lakes covered areas that are now land; the succession of lakes that formed with variations in the glaciers can be traced today by the beach lines they left. The meltwaters carried vast quantities of loose rock and silt. When the quantity and velocity of these waters decreased, this material was dropped to the bottom of streams or lakes. Such waterlaid material is called *glaciofluvial.*

Glacial lakes which have influenced the physiography of the watershed have been named Whittlesey, Arkona and Warren. A remainder of the beach line of Lake Whittlesey can be found today between the villages of Arkona and Watford. Another shoreline, that of Lake Warren, exists as a ridge running south-west from Forest in the Ausable Watershed to north of the village of Wyoming in Plympton Township.

Other legacies of glacial lakes are the level clay plains and river deltas.

For practical purposes, the watershed of the Sydenham River can be broken down into a number of distinct physiographic areas.

(a) *The Clay Plains*

Over one-half of the watershed is occupied by the physiographic region called the Lambton clay plain, a level, extensive, rather poorly drained area in the bed

of glacial lakes Whittlesey and Warren. The clay plain is made up of till with a rather shallow layer of clay and silt material. The major soils of this clay plain are the Brookston and Clyde clays.

Another clay plain occupies parts of Ekfrid and adjoining townships. Called the Ekfrid clay plain, it too is nearly level except for cuts made by the river valleys. The clay soils are mainly Brookston, Huron and Perth. Mingled through the clays are areas of silt, such as the Lambton silt loam.

Soils of both clay plains are naturally inadequately drained, and to cultivate them successfully, tile drains or open ditches are necessary.

The third clay plain in the watershed is a part of the Chatham flats. This 250 square-mile area east of Lake St. Clair extends into the north portions of the watershed in Chatham and Sombra Townships. The town of Wallaceburg lies on this plain. The clay soils here, as elsewhere, have only fair to poor natural drainage. Interspersed with the predominant Brookston and Thames clays of the plain are smaller areas of silts and sandy loams. The topography is low and level and the soils are highly fertile. Most of the area is used for cash crops.

(b) *The Sand Plains*

The stream which followed the present Thames River valley and flowed into glacial Lake Whittlesey built up the delta of sand material which is called the Caradoc sand plain. This plain covers most of Caradoc Township, with its northwest boundary following the Sydenham River Valley near Strathroy. There are two main soil types on the plain: the well drained Fox sandy loam and the imperfectly drained Berrien sandy loam. The topography is comparatively level.

The Bothwell sand plain covers parts of the Townships of Camden, Euphemia, Zone and Mosa. This area represents a delta of an earlier Thames River into glacial Lake Warren.

The sand materials are not very thick and are spread over an underlying clay floor. This results in poor drainage with scattered depressions of swamp and muck. Predominant soils are the imperfectly drained Brady sandy loam, Berrien sand and Granby sand. These soils are not highly developed for agriculture, and many areas are in poor pasture or are used for Christmas tree growing and reforestation.

One other small sand plain is found around Warwick Village in the north part of the watershed.

(c) *Till Plains*

Two small till plains extend into the upper portions of the watershed; one is in London and Lobo Townships and the other is in Warwick and Brooke. Both exhibit the gently undulating relief characteristic of till plains. Well drained clay soils such as Huron and Perth predominate.

A contrast in land management. In the foreground is a good hay crop; in the background, hawthorns grow on the same type of soil.

Clearing a woodlot for agricultural purposes in Sombra Township in the poorly-drained Brookston soils.

CHAPTER 2

LAND USE AND SOILS

1. Formation of Soils

Soils have developed from broken down rock material mixed with organic matter. The break-down of rock material has been accomplished over the centuries, not only by the glaciers but also by the action of such agencies as wind, sun, rain, frost—all grouped under the process called weathering. The fragmented rock material became mixed with decayed plant and animal material.

Examination of most soils will show that they are made up of layers which soil scientists call *horizons*. Horizons may be thick or thin and their colour and texture may vary. To assist in their description, soil horizons have been given letters. The main horizons are designated as "A", "B" and "C". Some soils may lack one or more of the horizons.

The "A" horizon is the uppermost layer of the profile. It is the surface or topsoil layer. Immediately below it is the "B" horizon or subsoil. The deepest layer is the "C" horizon, often called the parent material.

A *soil profile* may be described as a vertical cross-section cut through all the horizons. Such influences as type of bedrock, climate, slope, vegetation and drainage have a bearing on the formation of a soil profile.

There are many differences in soils. They can differ within a field, or from farm to farm and county to county. Examination of a county soil map for the Sydenham Watershed will show that there is a great variety of soils.

Soils of all counties in Southern Ontario have been surveyed. These surveys are conducted co-operatively by the Soil Science Department of the Ontario Agricultural College and the Canada Department of Agriculture. Reports and maps have been published for many counties. Where not yet published, information on a county's soils can be obtained from the County Agricultural Representative's office.

The soils of any area may be grouped according to the kind and origin of the parent material. These parent materials are derived from the bedrock. Soils formed from the same parent material will likely have many similarities. They may have similar horizons. A *soil series* is a group of soils that have similar characteristics but differ in the texture of the surface soil. Thus we have, for example, Brookston clay and Brookston clay loam. The series is the main unit of soil classification; each series has been given a name – often the name of the township or place near which the series was first mapped.

Soils that have originated from the same parent material, but which have been subjected to different drainage conditions during their development, may form different profiles. Differentiation on this basis is called a *catena*. Thus we may have well-drained, imperfectly-drained and poorly-drained soils developed from the same bedrock, and drainage conditions during their development will have significantly affected their qualities and characteristics.

A soil catena common in the Sydenham Watershed is the well-drained Huron clay, the imperfectly-drained Perth clay and the poorly-drained Brookston clay.

2. Soils of the Watershed

Over 50 per cent of the soils in the Sydenham watershed are classified as poorly drained with another 35 per cent as having only fair drainage. Over three-quarters of the watershed soils are heavy-textured. These characteristics present some problems in the use of the watershed soils, with drainage being the main difficulty.

More than 90 per cent of the Sydenham Watershed is occupied by soils of the following eight series:

(a) *Brookston Series*

Brookton soils, which occupy 52 per cent of the watershed, were developed from water-washed till and are the common soil of the physiographic region called the Lambton clay plain. The soil is poorly-drained, heavy textured, and predominantly clay or clay loam. Artificial drainage is essential for successful cultivation of this soil. With systematic drainage it will produce good crops of grain, alfalfa, corn and soy beans. Without drainage, cropping is almost limited to pasture and hay.

The soil is naturally quite fertile. Organic levels must be kept high to prevent puddling in wet weather. Erosion is not a problem.

(b) *Perth Series*

Perth soil, which occupies 13.3 per cent of the watershed, is also developed from water-washed till and is the imperfectly drained soil found in association with the poorly drained Brookston. Perth soils have an undulating topography. In this watershed they are all classified as clay or clay loams. Extensive areas are found in Warwick and Lobo Townships.

Perth soils need care in maintenance of organic matter levels. They will grow a variety of crops common to the watershed without artificial drainage. However, for fall wheat and alfalfa, artificial drainage is recommended.

(c) *Huron Series*

Huron soils, which occupy 3.6 per cent of the watershed, are found along the stream course of the Sydenham and about the headwaters in Lobo and London Townships. Huron, a well drained soil, is suited to most of the crops commonly grown in the watershed. Attention needs to be given to adequate organic matter content. Eroded areas of this soil should be kept in grass or tree cover.

(d) *Caistor Series*

This series, which occupies 7 per cent of the region, is a water-laid, fine-textured soil found in the watersheds of Black Creek and Bear Creek tributaries of the Sydenham, in Moore and Enniskillen Townships. Its fine texture and compact subsoil tend to impede drainage, and the soil is described as being imperfectly drained.

Caistor soils tend to be acid and are inherently low in organic matter. Crop residues and manure should be used on them. Lime is needed for some crops, and a high-phosphorus, complete fertilizer is necessary for satisfactory production of most crops commonly grown. Caistor soil is best suited to livetock and grassland.

(e) *Berrien Series*

Berrien soils, which occupy 6 per cent of the watershed, are sandy outwash material, underlain at three feet or less by water-laid clays or clay till. These sands in the Sydenham Watershed are the result of wave action in glacial lakes which left scattered sandbars. The Berrien sands and sandy loams are imperfectly drained. Berrien soil is not used extensively for agriculture; it is subject to wind eroison when left bare.

(f) *Fox Series*

Fox sandy loams and sands occupy 1.3 per cent of the watershed. They are developed from outwash material deposited by post-glacial lakes. Physiographically they are found in the area called the Caradoc sand plain. Fox soils are well drained with level to gently sloping topography. They are found mostly in Caradoc Township. Some nursery crops and tobacco are grown on them around Strathroy.

(a) *Brady Series*

Developed in the same manner as the Fox series, this soil is imperfectly drained. This series occupies 4.4 per cent of the watershed. Large areas occur in Euphemia Township. Natural fertility is medium to low. The soil is used for production of cash crops.

(h) *Haldimand Series*

A clay-loam, imperfectly drained, medium-textured soil, it occupies 2.5 per cent of the watershed. It is found mostly in Adelaide and Metcalfe Townships.

(i) *Other Soils*

Nearly 4 per cent of the area of the Sydenham Watershed is mapped as bottomland. These are soils adjacent to stream courses and subject to flooding during part of the year. The soil consists of layers of silt, sand and clay, often intermixed with layers of organic matter.

Bottomland is usually moist and the abundant growth of grass provides good grazing. Good yields of farm crops can often be obtained if serious flooding does not occur during the normal growing season of the crop.

Small areas of other soils mapped in the watershed include: Thames clay loam, Lambton silt loam, Burford loam, Granby sand and Tuscola silt loam. Together these soils account for less than 4 per cent of the watershed land area.

3. Agricultural Statistics and Land Use

Census figures given by counties and townships and information from other sources are the basis of this section. It is not possible, however, to break these figures down to conform exactly to the watershed area. Since 78 per cent of the watershed lies in Lambton County, the following figures are for that county. They may be taken as representative of the whole watershed.

The following graphs include one that shows major uses of the agricultural land of the county. These figures indicate that 20 per cent of the land was growing soy beans and grain corn—both row crops. Both are well suited to the climate,

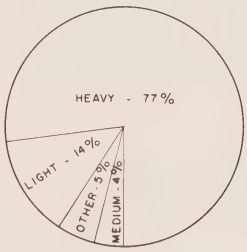
fertile soils and level land of the watershed. While such crops need good drainage for best yields, they are less affected by drainage problems than some other crops.

1961 Census statistics show that the largest acreage of cropland is used for hay, with about equal areas in each of wheat, oats and corn.

There are 4,200 farms (1961 Census) in Lambton County. Census returns give farm numbers in 1951 as 4,650; 1941 — 5,300; 1931 — 6,350.

Since 1941 there has been a decrease of more than 50 per cent in the number of farms reporting milk cows; the reported decrease in beef cattle is 10 per cent. It is likely that most of the farms that have gone out of cattle raising have turned to cash crop production. However, it is assumed that some of the extensive acreage of apparently idle land was once in mixed farming and was then reporting livestock.

LAND CONDITIONS AND LAND USE
SYDENHAM VALLEY CONSERVATION AUTHORITY

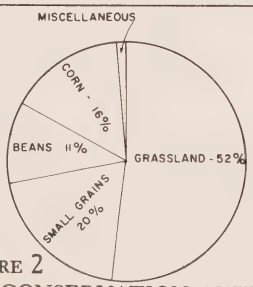


Soil Textures.

Heavy - clay, clay loam, silty clayloam.
Medium - loam, siltloam.
Light - sandy loam, loamy sand, sand.
Other - muck, peat, bottom lands.

Drainage Conditions.
Major Soils of Watershed

Good - Haldimand, Lambton, Fox,
Fair - Perth, Huron, Berrien, Caistor, Thames,
Poor - Brookston, Clyde,
Other - (often very poorly drained) Muck, Bottomland.



Small Grains	Winter wheat	11 %
	Oats	7%
	Other grains	2%
Beans	Soy	9%
	Dry	2%
Corn	Grain	11 %
	Fodder	5%
Miscellaneous	Tobacco, potatoes, sugar beets,	
Grassland	Cleared pasture	35 %
	Hay	17%

FIGURE 2

CONSERVATION AUTHORITIES BRANCH, DEP'T. E.&R.M., N.T., 1963.

Agricultural Land Use, Lambton County
Based on figures published for 1960 by the Economics and Statistics Branch, Ontario Department of Agriculture

CHAPTER 3

LAND MANAGEMENT

1. Introduction

Soils of the Sydenham Watershed are, generally speaking, fertile and capable of producing good crops. Many areas still require artificial drainage and cannot produce satisfactory yields until they are drained. Given this drainage, along with attention to organic matter content and satisfactory fertility levels, crop yields can be excellent. Many of the soils are particularly suited to the growth of grass.

Extensive areas of the watershed are currently being under-used. With drainage, most of the land could be cultivated and rotations, including extensive grass planting, could be used.

2. Land Classification

Land classification helps to organize all of the soil facts of significance for conservation use. The system is based on the soil map and on such other physical information as topography, slope, drainage, erosion susceptibility and freedom from stones. It is designed to help show the suitability of land for crops, pasture, forestry and wildlife uses. It is a practical grouping, based on the needs and limitations of soils, the risks of damage to them and the response to management.

In this system arable (workable) lands are grouped according to their potential and limitations for sustained production of the crops common to the area. Non-arable soils (those unsuited to sustained crop use) are grouped according to their potential and limitations for the production of permanent vegetation (grass and trees).

Eight divisions or classes are used. Arable land falls into one of Classes I to IV, while generally non-arable lands are placed in Classes V to VIII. Each class groups together soils that can be used in much the same way and that have the same relative degree of hazard or limitation. The risks of soil damage or limitation become progressively greater from Class I to Class IV. There may be many different kinds of soil in one land class.

3. Land Classes

A—*Lands Suited to Cultivation and Other Uses*

Class I: Soils having few if any limitations to restrict their use.

Class II: Soils having some limitations that reduce the choice of crops or that require some conservation practices.

Class III: Soils having moderate limitations that reduce the choice of crops and require special conservation practices.

Class IV: Soils having severe limitations that restrict the choice of crops and require careful management.

B—*Lands Limited in Use—Generally Not Suited to Cultivation*

Class V: Soils having little or no erosion hazard, but other limitations restricting their use largely to pasture, woodland or wildlife.

Class VI: Soils with severe limitations that make them unsuited to cultivation and restrict their use to pasture or range, woodland or wildlife.

Class VII: Soils with very severe limitations that restrict their use to light grazing, woodland or wildlife.

Class VIII: Soils and land forms in this class have limitations that preclude their use for other than recreation, wildlife, water supply or aesthetic purposes. There are no lands of this class in the watershed.

Some farmers have found it useful to have a complete farm plan made for their land. Such plans map and describe the different land classes on the farm. This information enables the farmer to have a complete inventory of his farm's soil—its kind, type and capability. Such service can be obtained without charge from the soil specialists of the Ontario Department of Agriculture and Food.

4. Land Use Problems

From the physical standpoint, most of the problems concerned with the use of soils in Southern Ontario are associated with fertility, drainage and erosion.

(a) *Drainage*

Of the several problems of soil management, the major one in the Sydenham Watershed is that of drainage. Nearly 95 per cent of the land has some drainage problem, with over half being rated as only poorly drained. In this watershed, artificial drainage by open ditches or tile is one of the most important requirements for management of the land. Without drainage, many areas in the watershed cannot be cultivated profitably, and some cannot be cultivated at all.

Municipal drainage ditch in Sombra Township, showing outlets to tile drain systems.

(b) *Fertility*

Soil fertility is the ability of a soil to supply the nutrients necessary to plant growth. Maintenance of soil fertility is one of the major tasks of soil management in this province.

Differences in soil fertility may be inherent in the soil itself or may be related to past management conditions.

The use of fertilizers becomes necessary when crop responses indicate a lack of one or more of the most needed nutrient elements in the soil. However, maintenance of soil fertility is more than the application of fertilizer. It also includes the building up and retention of adequate organic matter. Incorporation of crop residues and green manures into the soil and applications of barnyard manure increase or maintain organic matter. Adequate humus levels are necessary to retain soil structure and make the best use of commercial fertilizers.

Proper analysis of soil is necessary to determine what kind of fertilizer and how much is needed. Soil sampling equipment and instructions can be obtained from the Agricultural Representative's office.

(c) *Erosion*

Soil erosion, caused by wind or water, may occur on any land that is cultivated. In Ontario, soil erosion is more often caused by water run-off from cultivated land.

In the Sydenham Watershed, soil erosion, except in a few small areas, is not a serious problem. Most of the erosion is confined to the steeper slopes of the valley along parts of the river and some of its tributaries.

The lighter soils near Strathroy are extensively used for nursery and cash crops. This commercial nursery is located on Fox sandy soil.

5. Conservation Measures

Some general principles and practices of good soil management apply to the agricultural land in the Sydenham Watershed. These might be summarized as follows:

(1) Using each piece of land within its capabilities and treating it according to its needs.

(2) Managing the soil to maintain, and indeed to improve, soil fertility.

(3) Controlling water removal from the soil, both from its surface and from within.

(4) Selecting the best varieties of row and grain crops, grasses and legumes for the soil and the climate.

(5) Rotating crops when necessary to improve soil tilth.

It is not the purpose or aim of the Conservation Authority to interfere with the freedom of choice of any landowner in deciding on his soil management. A Conservation Authority, however, is given the responsibility of protecting the resources of a watershed, and hence must be concerned with the use of the farm land. Its erodibility, its productivity and its fertility are going to have an effect on the water, forest and wildlife resources of the area.

A Conservation Authority seeks to encourage proper and economic uses of the land. Authorities work in close co-operation with the Department of Agriculture and its county agricultural representatives, with the Ontario Agricultural College and with the farm organizations of the region. Each of these departments and organizations has certain facilities and services to offer landowners. A Conservation Authority in turn has its own unique services and assistance to offer. Taken together these can all work to the betterment of the soil and land resources of the watershed.

Conservation measures needed to maintain and improve the land resources of the Sydenham Watershed include: rotations, improved grasslands, more drainage and attention to soil fertility and good management of water supply.

(a) *Grasslands*

Grassland is hay and pasture. For years, pasture was regarded as a second-rate crop by most farmers. Fields unsuited to crops were left to pasture. In contrast, many farmers now find that good pastures are an important part of livestock farming.

There is an extensive livestock industry in the Sydenham Watershed. The fertile soils respond to intensive grassland production. Unfortunately, large areas of pastureland are poorly managed. Thousands of acres are becoming overgrown with hawthorn. Some of this poorly managed land needs drainage.

In view of the probable demand for greater beef production in Eastern Canada in the near future, better pasture management could support much higher cattle-carrying capacity. The extensive acreage of the watershed now overgrown with hawthorn will be difficult and expensive to clear and return to effective cultivation. Many more acres are in the early stages of hawthorn infestation. Each year such land becomes harder to clear up. Every effort should be made to curb the spread of hawthorn. The Authority should work with the agricultural organizations to encourage an interest in and develop methods for hawthorn clearance.

(b) *Drainage*

The Department of Agriculture and Food supplies technical assistance on drainage surveys. The services of an agricultural engineer can be secured through application to the office of the Agricultural Representative.

The soils of the Sydenham watershed can produce good pasture for beef and dairy herds.

(c) *Farm Ponds*

In many areas the demands on farm water supply are increasing. This demand comes from greater numbers of livestock, running water supply in farm homes, and use of water for spraying and irrigation. On many farms, wells are not able to supply this increased water demand.

Farm ponds can be an excellent source of water, either as a regular supply or for emergency purposes. If located near buildings, they provide a means of combatting fire. They can be a source of water for irrigation and spraying, and may also have value as a recreation amenity or as a habitat for fish and wildlife.

The heavy clay soils will hold water in a pond. The ponds may get water supply from surface run-off, springs, ground water, or a permanently flowing stream.

The Authority should publicize the value and use of farm ponds. At the same time, they should publicize the necessity of adequate and proper construction of farm ponds and small dams. Many ponds have failed because of improper construction or poor location.

Information and assistance on construction of ponds can be secured from the Authority office, or from the Agricultural Engineering Extension Specialist of the Department of Agriculture and Food.

(d) *Land Judging*

In recent years, land-judging competitions have become popular in some counties of Ontario. These events are primarily of interest to rural youth and young farmers.

The purpose of these "land judging" events is to teach young people how to know the soil, and make the best use of it. Land judging helps develop an understanding of soil management and conservation. The judging is done in much the same way as that of livestock. Soils are examined for texture, drainage condition, erosion, slope and depth of topsoil.

The Authority should continue to co-operate with the Department of Agriculture and Food in sponsoring these worthwhile events.

It is recommended that the Authority co-operate with the Department of Agriculture and Food and with local farm organizations to promote interest in good farm management. Some such measures might include:

(1) Demonstrations of pasture management, erosion control and grassed waterways on private or Authority-owned land.

(2) Erosion control measures along streambanks and the rolling land adjacent to stream courses.

(3) Demonstrations and research into the control of hawthorns.

(4) Continued assistance, both financial and technical, for the building of farm ponds.

(5) Continued support of land-judging competitions as one of the most effective means available to promote interest in soils among rural young people.

PART II - FORESTRY

A well-managed twenty year old white and red pine plantation. Note the piling methods and skid road clearing.

CHAPTER 1

THE FOREST IN THE PAST

1. Early Surveys

Good early descriptions of the forests of Southern Ontario are rare. In many areas, however, a reasonable picture can be pieced together from notes of the surveyors who laid out the townships in preparation for settlement.

The condition and species of timber and the site on which it was observed during early surveys are in harmony with present knowledge of the physiographic features of the Sydenham River Watershed, and may provide some insight as to the application of forestry techniques on the watershed in the future.

The various original surveyors of all the townships in the watershed were continually working through small areas of "good land" covered with "Beech, Maple, Bass.," with "Oak and Hickory" inclusions at times, interspersed with small "Black Ash & Elm Swamps".

Peter Carroll, surveyor of both Adelaide and Warwick Townships, described the nature of the soil and its cover in the northern headwaters region of the Sydenham River principally as "good land, uneven surface" with "Ma, Beech Elm & Bass." on it. Ironwood and white oak sometimes occured as included species in the normal maple-beech association. Lowland, when it was found, was described as such and evidently supported forest cover of "Black Ash and Elm". In some cases Carroll would cross "open Marsh" with "Willow and Rose Bush".

London and Lobo Townships, surveyed by Mahlon Burwell in 1810 and 1820, generally possessed good soils, covered mainly with maple, beech, elm and basswood. Small wet pockets of black ash and elm occured as well.

In London Township, plum and crabapple groves were found in the upper Sydenham River valley.

The parts of Caradoc and Ekfrid Townships within the Sydenham River Watershed also had a series of pockets covered with maple, beech, and some ash or elm on "good land" and black ash and elm in small swamps. Tamarack swamps were common in Ekfrid Township and on its common boundary with Caradoc Township. Tamarack was evidently the only coniferous tree species on the watershed, excepting some small cedar patches observed in the north-east headwaters region.

The eastern part of Ekfrid Township within the watershed was extremely swampy, as described by Burwell in 1820:

> "I found the swamp got so bad that I could proceed no further, so thought most practicable to return to the Township . . ."

In the townships of Brooke, Enniskillen, Dawn and Sombra, by plotting the positions of the existing forest cover, one can see that the swamp area in these townships was enormous. The swamp, composed mainly of black ash and elm was broken only by the Sydenham's main stream and tributaries. This swamp area appears to have covered at least all of Sombra Township east of the main river, all but the south-east part of Dawn Township, that half of Brooke Township west of the Sydenham, and most of Enniskillen Township between the North Sydenham River and Black Creek. The remaining land was described as "good land" by the various surveyors and was forested with maple, beech, red and white oak, elm, hickory, and some tulip, sycamore and cherry. The pattern of small black ash

swamps also prevailed on good land, some of them, particularly in north Dawn Township, being described as having "a general connection one with another".

Thos. Smith, in 1820, wrote this description of Sombra Township:

> ". . . perhaps there never was a more painful survey — at the breaking up of the winter — & a flat country covered with Ice & water three fourths of the year. . ."

In contrast, Rosswell Mount wrote the following description of the lands of Moore Township in 1829:

> ". . . it gives me pleasure to observe that a great proportion of them are good, and some of them excellent. The Flats of Bear Creek are in many places rich & extensive, timbered with Ma, Beech, Elm Bass. & B. Walnut — The uplands — the soil of which, in most instances, is composed of clay, are strong and good, timbered generally with Beech, Ma. W. Oak, Elm, Bass., Ironwood & Hick."

In all the townships, the various surveyors noted the occurrence of black walnut when crossing the valley sides of the river and its tributaries. They also frequently described "thorn bottoms" or plum and thorn "bottoms" in these stream valleys. Hawthorn on the flat land areas beyond these river valleys appears to have been a rare occurrence. The source of present-day infestation, therefore, probably came from these valleys as the adjoining land was drained and cleared.

Observations of walnut appear more frequent in downstream areas. Park, during his survey of Dawn Township, noted down the presence of black walnut each time he crossed "Bear Creek" (Sydenham River). It is also interesting to read in the old survey notes that on the south boundary of Dawn Township on the first 39 chains across Concession X, Park says that it was "high & dry land, to an old Indian Sugarbush, land excellent, sandy soil". This description indicates an early form of maple sugar manufacture on the watershed.

2. Clearing the Land

Due to the large areas of swamp in the central Lambton County section of the watershed, settlement tended to start on the edges of the watershed and move inward. Development proceeded along the navigable channels of the lower sections of the Sydenham River, from Lake Huron along the main road from London to Sarnia, and from the settled areas of the neighbouring Lower Thames River watershed.

Elsewhere on the Sydenham Watershed, settlement had started in the early 1830's.

Plympton, on the north-western height of land, developed mainly from Lake Huron eastward. By 1846, it contained more than 100 households. William H. Smith describes the soil and timber of the township as "of very fine quality, the land being generally rich, and the timber the best kinds of hardwood. Large quantities of potash have been made in Plympton in the last two years" (1844 and 1845), "which is generally found to more than pay the expense of clearing the land. During 1845 a very large quantity will have been made".

In Dawn Township an "immense" trade in white oak staves made of timber from the river banks was under way. There was also an ashery in the township.

At this period Enniskillen had only 347 acres under cultivation but the township already possessed one grist and saw-mill.

From "Canada, Past, Present and Future" (1851) by W. H. Smith, we learn that Dresden was considered to be a thriving settlement of recent origin. By 1849, there was a steam saw-mill at the village and the lumber trade was flourishing. It was considered then that "being a shipping port for what will ere long be a fine agricultural county, besides being in the heart of a large supply of fine white oak, there is no doubt that the village will eventually become a place of considerable local importance".

Near Dresden on the Sydenham River there was a settlement of coloured people, called the "British American Institute". By the year 1848, they had erected a steam sawmill which was considered "a convenience to the neighbourhood". There was also a mill upstream at Dawn Mills. However, the area between Dresden and the "Forks" of the Sydenham River was largely uncleared in 1849 despite the fact that it was good land.

By 1850 it was said of Wallaceburg that although it might eventually become important, it was under the blighting influence of the "immense quantities of marsh and swamp within convenient reach". The immediate neighbourhood contained large tracts of the finest white oak timber. The town had two steam-powered mills, one of which "had seven saws and one run of stones for grinding wheat". Among the goods exported from Wallaceburg in 1850, lumber was prominent.

Though they were considered to have excellent lands for cultivation despite large wet areas, neither Enniskillen nor Brooke Township was much settled by 1850. However, William H. Smith records that 400 acres in the north-west of Enniskillen Township near the Sydenham River were used principally as a sugar-bush.

Plympton Township, evidently, had not seen much settlement because absentee ownership of large amounts of land delayed the construction of a good road to Sarnia. A great deal of potash had been made in the township, but by this time, when the price was low, it was considered unprofitable because "the best potash, (source) elm, grows on land which generally requires considerable draining before it is fit for cultivation".

In Warwick Township the situation appears to have been better, since larger clearings had been made on the London to Sarnia road through the township, particularly at the eastern end. There was a large clearing two miles west of the village of Warwick made by an Irish gentleman called Kingstone who had also built a sawmill.

An interesting description of the early use of the local forest is to be found in the Adelaide Township chapter of the History of the County of Middlesex. Hiram Dell, a pioneer merchant of Strathroy, writing under the date June 15, 1872, said of the building of his family's first home:

> "We made it twenty feet long by twelve feet wide, split out of basswood boards for a floor, — they were about four inches thick. We put the round sides down, and straightened the edges with our axe. If we got them close enough together so that we could not get our foot through, it would do. The next thing was to roof our house. The bark of a large basswood supplied the material."

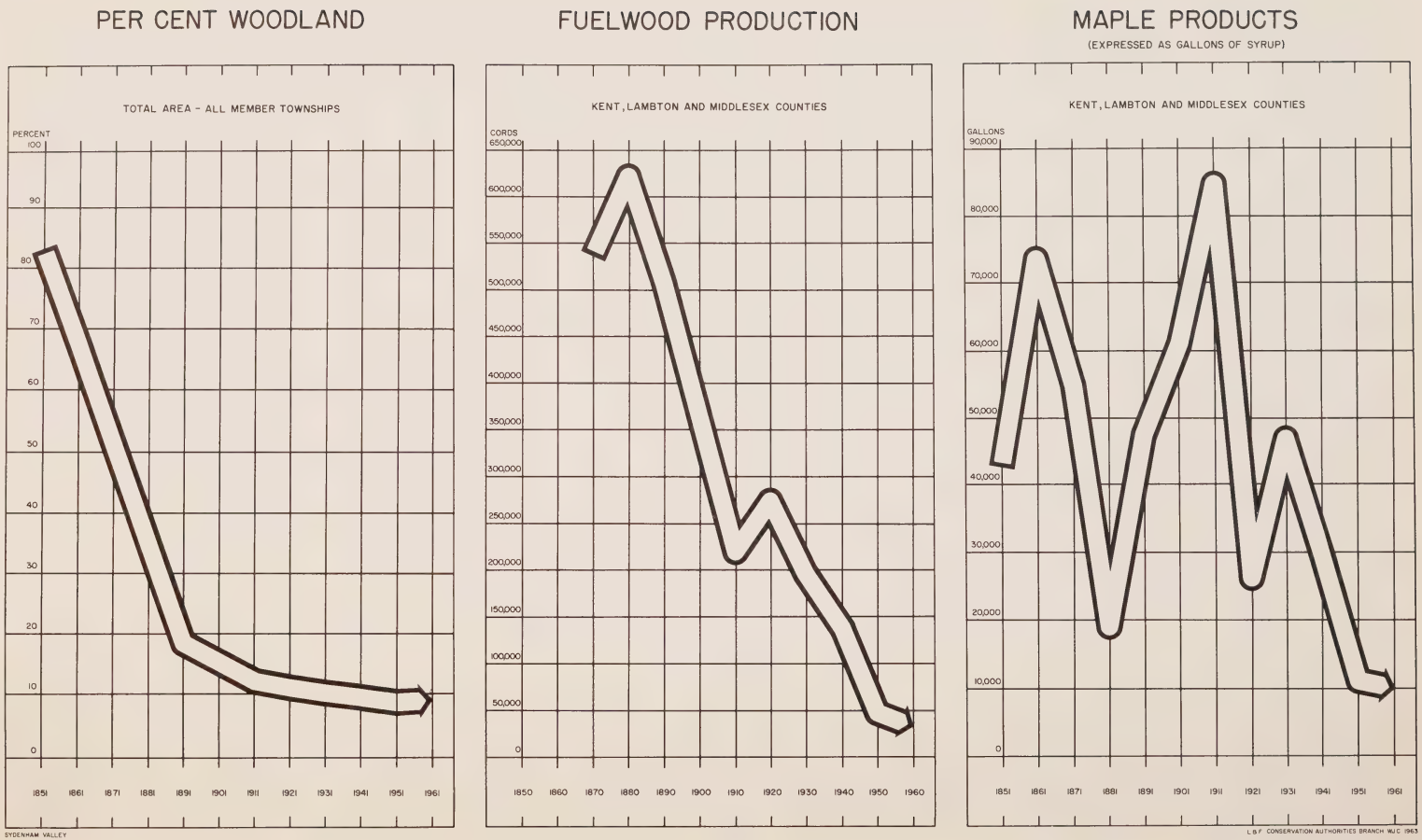

PER CENT WOODLAND
TOTAL AREA - ALL MEMBER TOWNSHIPS
PERCENT
100
90
80
70
60
50
40
30
20
10
0
1851 1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961
SYDENHAM VALLEY
FUELWOOD PRODUCTION
KENT, LAMBTON AND MIDDLESEX COUNTIES
CORDS
650,000
600,000
550,000
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1850 1860 1870 1880 1890 1900 1910 1920 1930 1940 1950 1960
MAPLE PRODUCTS
(EXPRESSED AS GALLONS OF SYRUP)
KENT, LAMBTON AND MIDDLESEX COUNTIES
GALLONS
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1851 1861 1871 1881 1891 1901 1911 1921 1931 1941 1951 1961
L.&F. CONSERVATION AUTHORITIES BRANCH W.C. 1963

FIGURE 3

3. Forest Products

Data on forest products pertinent to the Sydenham Watershed is taken from the Census of Canada.

In both Kent and Lambton Counties, 1870 to 1880 was the decade during which a peak was reached in the square timber manufacture of oak. The manufacture of material from this species was replaced by that of birch and elm, which reached a peak in 1890 and dropped during the 1900's. By 1910, these species ceased being used for this form of timber production. In the Lambton County census for 1910, maple square timber manufacture was at a high. After that date the Census no longer records squared timber.

Hardwood lumber production in Kent and Lambton Counties was of considerable significance to the economy of the area. Elm was the main species used for lumber production, reaching a peak in 1880 and dropping to a small volume by 1910. The production of hickory ranked next after elm though it was produced in much smaller volumes. Maple, birch, butternut, and walnut were important enough to be listed separately until the 1890's.

The production of such products as railway ties, poles, fence posts, masts and spars, lathwood and tanbark in the two counties reached a peak in 1890 and decreased rapidly in following decades.

Census figures show that a relatively small quantity of tamarack was cut as log material from 1870 to 1890.

In Middlesex County, as in Kent and Lambton Counties, the square timber industry relied mainly on oak, reaching a peak of production in 1880, then dropping sharply during the following decades. By 1910, oak had been virtually eliminated from the square timber industry.

From 1880 to 1890, the production of square timbers from birch, maple and elm became significant, due possibly to the decreased supply of oak. The use of birch and maple for square timbers was at a peak in 1890, then decreased slightly in the following decade. Elm, on the other hand, reached a peak in 1900 and decreased significantly in 1910.

In 1920, no square timber is shown and from this time on lumber production showed a decreasing trend.

Hardwood lumber was still a staple product until the early 1900's, with elm being the main species, having a peak in 1870, then dropping until in 1910 the species was of little significance. This was followed in abundance by maple and birch until 1880, hickory and butternut with peaks in 1880, and walnut in 1870.

Softwood lumber production was restricted to quantities of tamarack which reached a peak during 1870 to 1880 and dropped until in 1900 no tamarack lumber is shown.

Soon after 1900 such products as tanbark, lathwood, masts and spars dropped from the list and production of other products showed a sharp decline.

The one product which has persisted throughout the decades is fuelwood. In the three counties in which the watershed is situated the overall fuelwood production reached a peak in 1880, fluctuating between a peak of 622,000 cords that year and a low of 30,000 cords in 1960. This decline reflects both the decrease in available supply and the increasing competition of other fuels.

The development of the region is reflected by the addition of fence posts, poles and railway ties in the 1890 Census. The introduction of wire fencing, the develop-

ment of the telephone and the expansion of telegraph service all stimulated forest production at this period. The subsequent sharp decline in these products shows the rapid depletion of supplies.

The native chestnut does not appear as a separate species, but it was valued for interior trim in houses as well as for fence posts and rails. In the early days of the present century, a disease, the chestnut blight, practically wiped out the species, but for years a few sprouts and durable dead stubs of trees persisted. Two specimens of tree size were found during the survey of the adjoining Lower Thames Watershed, but none on the Sydenham River Watershed.

During the late nineteenth century maple sugar was almost the only sugar source available to the pioneers. By 1910, however, maple syrup was no longer a pioneer necessity; it had become a modern luxury. The peak production year of maple syrup was 1911, in all counties in the watershed.

CHAPTER 2

THE SURVEY OF PRESENT WOODLANDS

1. Introduction

The Sydenham Valley Conservation Authority lies wholly within the Deciduous Forest Region. The prevailing associations of forest trees are oak—hickory on drier soils, hard maple — beech on fresh soils, and oak — ash on wetter soils. Associated with these are yellow birch, elm, tulip, walnut and sycamore. In addition, there are scattered specimens of less common indigenous species such as chestnut, paw-paw, flowering dogwood, black gum, blue ash, sassafras, honey locust and the rarer oaks.

Information indicates that in view of the agricultural potential of this region, areas of open land should be used for agricultural production. Idle lands, it is believed, are best assigned to an improved pasture and livestock economy rather than a pure forest economy.

Farm woodlots are often part of farm properties on the watershed. The Authority's efforts are best directed toward improving the condition of these woodlots and making them more complementary to agriculture.

Certain forest conservation problems exist on the Caradoc and Bothwell Sand Plains. These plains lend themselves to the application of present-day forestry techniques of large-scale planting on idle areas.

Gullying by the tributary system of the river is common. On the main North Sydenham this is confined to small tributary streams north and south of Duthill. It then becomes more clearly defined as the river divides into the Bear Creek and Black Creek systems. Gullying continues upstream on Bear Creek into Warwick Township around the village of Warwick. Gullying in Black Creek occurs up to areas two to three miles north of Oil Springs.

On the South Sydenham River gullying occurs on the main stream on Long and Mollys Creeks at Dresden. It begins again just south of Florence and continues into the main tributary system, on Haggerty and Fansher Creeks, on Brown Creek to Watford, Hardy Creek, Morrogh Creek and on the main stream to a point near the north-west corner of Caradoc Township.

2. Survey Methods

For the detailed forest survey of the Sydenham Valley Conservation Authority, aerial photographic mosaics, each covering about 1,000 acres, were provided to the forestry party. Mapping in the field was done directly on these photographs.

Because of the well developed agricultural economy of the watershed, it was considered that the forestry practices required on the watershed would have to be specialized and complementary to agriculture. Therefore the survey itself was designed and undertaken in four sections:

(a) The mapping of major areas suitable for and requiring reforestation, and suitable for an Authority Forest.

(b) The mapping of erosion in the major gully system created by the tributaries of the Sydenham River, and the areas directly influenced by this gully system which are wooded or require reforestation for erosion control.

(c) The mapping of all areas of major hawthorn cover, so as to ascertain its influence on the watershed.

(d) The detailed examination of all woodland in a representative sample consisting of every fifth block within the watershed, plus those blocks that contained land which might be considered for an Authority Forest.

Within these sample blocks, each area of woodland, scrubland, swampland, and rough land was visited and described as to acreage, cover type, presence of grazing, reproduction, and average diameter at breast height. Each woodlot was classified as hardwood, coniferous or mixed. The term *hardwood* is used to denote all broad-leaved trees regardless of their physical hardness. A woodlot in which 80 per cent or more of the trees are hardwoods is called a hardwood stand, one in which 80 per cent or more of the trees are conifers is called a coniferous stand, and all other stands are classed as mixed wood.

Plantations were likewise examined and records made of the method of planting used, approximate age, care, damage and survival.

3. Forest Cover Types

The term *forest cover type* refers to those combinations of tree species now occupying the ground, with no implication as to whether these types are temporary or permanent.

The following cover types were encountered on the Sydenham Valley Watershed:

Aspen
Poplar — oak
Pin cherry
Hemlock
Sugar maple — basswood
Sugar maple
Tamarack
Bur oak
Black locust
White oak — black oak — red oak
White oak — black oak — hickory
White oak
Red oak — basswood — white ash
Red oak
Beech — sugar maple
Beech
Ash — hickory
Silver maple — white elm
White elm
Willow

Although twenty cover types were identified on the watershed, six cover types dominated nearly 90 per cent of the sample woodland:

1. Silver maple — white elm is a cover type occurring in swamps, flood plains and poorly drained soils. Such land is unsuitable for general farming unless completely and adequately underdrained.

2. White elm occurs in stream bottoms and on swampy depressions when the land is too wet for agricultural purposes unless completely underdrained. Dutch elm disease has made inroads into these stands, thereby reducing their timber potential.

3. Beech — sugar maple is a cover type preferring moist, fertile soils. Thus its acreage has been gradually depleted by clearing operations for agriculture.

4. Ash — hickory is usually a residual cover type following cutting and grazing. It is commonly composed of white or green ash and shagbark and bitternut hickory.

5. Sugar maple is connected with the better soils of the watershed. It usually occurs as well developed and well tended sugar bush stands.

6. Aspen is a pioneer cover type which follows clear-cut operations, over-grazing or fire. It is a frequent invasion species on abandoned fields and pastures. Though it avoids the wettest swamps, it does grow on soils that are wet throughout a good part of the year. It occurs as well on droughty soils.

Only two other cover types occupy areas of over 2 per cent of the woodland area examined. These are oak types.

4. Condition of Woodlands

Of all the woodland in the sample blocks examined on the Sydenham Valley Conservation Authority area, only 0.1 per cent was coniferous and 0.01 per cent mixed-wood. The remainder was entirely hardwood. Some additional coniferous growth in the watershed was found in plantation form. The total area sampled amounted to 25,644 acres.

On the Sydenham River watershed, woodlots commonly form a pattern along the rear of individual properties and along sections of streambanks. In areas on the Bothwell Sand Plain where agriculture is not so intense, woodlots generally are of larger size and follow no particular pattern. Woodlot sizes tend to decrease greatly from Dresden to Wallaceburg on either side of the South Sydenham River in Kent County due to the intensity of "cash-cropping" in the area. This condition continues through Lambton County to areas around the same two towns.

Of the wooded area examined, 6 per cent contains stands classified as over 18 inches in diameter at breast height and 57 per cent were in the 10-18 inch diameter class. Therefore, 63 per cent of the standing timber is merchantable in some form.

Hardwood woodlots of silver maple and elm are the most common forest cover on the watershed.

Of the remaining wooded area, 31.5 per cent is in the 4-10 inch diameter class or "pole" stage which is at least partially merchantable. The remaining 4.9 per cent is under 4 inches in average breast height diameter, being made up of small wooded lots that are regenerating after cutting. It appears therefore that most of the watershed's woodlots have some merchantable timber (even though the gross volume may not be great) and could show early returns from better management.

Most of the wooded area examined was uneven-aged (85.9 per cent). It appears that much of the watershed's existing wooded area can produce continuous modest sources of revenue due to the multi-storied uneven-aged structure and the amount of merchantable timber.

Stocking is good in 29 per cent of the watershed's woodlands, with 48 per cent being slightly understocked. Further indication of the need for more concentrated natural woodland management is borne out by the fact that 19.8 per cent of the region's woodlands are severely understocked. Thinning is necessary on 3.1 per cent of the wooded area due to overstocking, mainly in Ekfrid, Mosa and Warwick townships.

Understocking should receive attention in Chatham, Metcalfe, Enniskillen, Camden, Caradoc, Plympton, Adelaide and Sombra townships. These townships have been listed in order of the prevalence of understocking.

Regeneration is a particularly pressing problem on the watershed. Only 10.2 per cent of the wooded area examined proved to be regenerating satisfactorily. On the remaining wooded areas 53.1 per cent were reproducing subnormally and 36.7 per cent were reproducing either poorly or not at all.

This latter condition is explained to a considerable extent by the fact that 50.8 per cent of the woodlot area examined had been grazed. This is a practice that can be stopped by simply fencing these woodlots, and yet over 80 per cent of the sampled woodlots were unfenced.

Grazing is detrimental to woodlots and should be stopped by fencing cattle out.

The grazing of woodlots has a definitely bad effect on them. It inhibits regeneration and particularly the production of desirable timber species. It is common to find woodlots on the watershed with considerable grass cover on the forest floor. The grazing of this type of meadow is neither good forest management nor good animal husbandry. Although some tree species may not produce leaves succulent to cattle, farm animals can prevent regeneration by trampling seedlings. Disease can be transmitted to trees through scuffing wounds caused by animals.

The owners of grazed woodlots can make their properties more productive by fencing their animals in adjacent permanent pastures. Woodlots then can be used as shelterbelts as well as timber producers. Tolerant stands will regenerate well and naturally as a result. Intolerant woodlots can have their seedling layer replenished by the creation of special openings during cutting to produce a form of multi-storied group forest, by scarifying the ground in these openings if necessary, or by planting the forest floor by hand with suitable species.

5. Scrublands

During the survey, 7,082 acres of dry scrub and 1,040 acres of wet scrub were found. These are areas covered with tree species that will never attain commercial size. The most common species are scrub willow and dogwood on poorly drained sites and hawthorn on dry sites. Much of this growth is on abandoned farmland or neglected pasture. Hawthorn is one of the most common forms of tree cover on the watershed.

By further reconnaissance as well as aerial photo interpretation, it was concluded that the total area of hawthorn cover on the watershed was about 15,000 acres.

In some cases scrubland can be restored to agricultural use through drainage or through eradication of the dry scrub. However, where such restoration does not seem economically feasible, the area should, where possible, be returned to better tree cover through systematic replacement of scrub with more valuable species.

Hundreds of acres of land in the watershed have become overrun with hawthorn. (The land can be productive.)

It is noticeable on the Sydenham River Watershed that hawthorn cover is in many cases associated with the banks and major gullies of the river's two main streams and some of the tributaries. Of the total hawthorn cover, 23.8 per cent functions as a form of erosion control. However, in most cases, hawthorn has been allowed to encroach unnecessarily onto neighbouring fields, an infestation undoubtedly deriving from the "thorn and plumb bottoms" of the early 1800's.

The estimated area of dry scrub by townships within the watershed is as follows:

Adelaide, 867 acres; Brooke, 1,184 acres; Camden, 70 acres; Caradoc, 340 acres; Dawn, 342 acres; Ekfrid, 88 acres; Enniskillen, 4,871 acres; Euphemia, 406 acres; Lobo, 81 acres; Metcalfe, 1,625 acres; Moore, 1,815 acres; Mosa, 987 acres; Plympton, 378 acres; Sombra, 874 acres; Warwick, 864 acres; Zone, 239 acres.

When mapped, it is evident that dry scrub cover has become a problem principally on the middle reaches of the river. By townships, the hawthorn distribution as a possible conservation problem can be described as follows:

(a) *Adelaide Township* — Scarcely any of the scrub areas in this township have any connection with gully systems, being confined to unnecessary patches of from 8 to 110 acres in size in the fields.

(b) *Brooke Township* — About 13 per cent of the hawthorn acreage in this township is in patch form in open sections away from streams. Of the remainder, which is closely associated with stream banks, 41 per cent has been allowed to invade both forest and open level lands adjacent to the eroded areas on the river valley.

(c) *Camden Township* — Hawthorn cover is in small patches on agricultural fields only, in this township, and should present no removal problem.

(d) *Caradoc Township* — Hawthorns on farms cover patches ranging from 16 to 67 acres in size and not functioning as a natural erosion control anywhere.

(e) *Dawn Township* — Less than 20 per cent of the hawthorn cover in this township could be considered to be contributing to gully control. The remainder, in patches of from 9 to 90 acres in size, would be better removed.

(f) *Ekfrid Township* — Hawthorn cover in this township is in three scattered areas and from 14 to 60 acres in size, creating no particular agricultural problem except that it can contribute to further infestation in fields. However, areas of up to 60 acres covered in this fashion are producing nothing useful.

(g) *Enniskillen Township* — Extensive hawthorn infestation exists east of Petrolia in the oil fields, undoubtedly caused by original land neglect during oil field development. This is part of the region of hawthorn cover in this township, occuyping about 3,500 acres directly associated with the valleys of Bear Creek and Black Creek. However, only 32 per cent of this cover is acting as a direct natural erosion control.

Hawthorns cover another 1,373 acres of this township, in sections which cannot contribute to erosion control in any way.

Hawthorn infestation nearing the stage of crown closure. The clearing can be planted readily but closed areas require expensive scrub removal before reforesting.

(h) *Euphemia Township* — Of the total acreage of hawthorn cover in this township, only 5 per cent functions as a natural erosion control. The remainder, in areas ranging from 10 to 69 acres in size, is detrimental to agriculture and useless as forest cover.

(i) *Lobo Township* — Dry scrub covers a small acreage not associated with effective erosion control. It is broken up into scattered patches that should present no real control or removal problem to private property owners.

(j) *Metcalfe Township* — About 1.3 per cent of the hawthorn cover is in the form of patch invasion of fields apart from the gully systems. The remainder is associated with major gully systems of the upper main stream section of the East Sydenham River, of which only 39 per cent can be considered as a form of natural erosion control.

(k) *Moore Township* — About 800 acres of hawthorn are closely associated with the valley of the North Sydenham River. However, only 50 per cent of this acreage is acting as a natural erosion control.

Over 1,000 additional acres of the hawthorn cover in this township consist of unnecessary invasions of fields and woodlots.

(l) *Mosa Township* — An area of 652 acres, of which only 41 per cent can be considered as a natural erosion control, is associated with tributaries in the middle reaches of the East Sydenham River.

Agricultural fields have been invaded by hawthorn in this township in other areas of from 28 to 125 acres in size and totalling 235 acres.

(m) *Plympton Township* — About 70 acres of the hawthorn cover in this township is acting as an erosion control on the main stream of the North Sydenham River, east of Wyoming. The remainder is in patch form and has principally become part of woodlots along the rear boundary line pattern. These may not be considered a serious problem but can still contribute to the infestation of neighbouring agricultural areas in the future.

(n) *Sombra Township* — Most of the hawthorn acreage in this township, with the exception of of one large area west of Wilkesport, has invaded fields not associated with the main river valley. This scrub should be cleared for agriculture except in the few cases where the river banks have been covered.

(o) *Warwick Township* — A total area of 621 acres of hawthorn cover is associated in some way with the Upper North Sydenham River and Brown Creek near Watford. Only 37 per cent of this is functioning as an erosion control. The remainder, plus the acreage not associated with streams, has infested essentially agricultural areas.

(p) *Zone Township* — The principal hawthorn cover in Zone Township is found in four areas, none of which are associated with natural gully control. They constitute parts of natural woodlots or agricultural field infestations that should receive attention now before further encroachment occurs.

Hawthorn cover in the initial stages of infestation also exists on the watershed. In most of such cases the choice can still be made whether to clear this scrub for agricultural crops if desired or to plant it to trees. If the land is not required for agriculture, the latter is the most productive and profitable method employable to prevent scrub increase. If planted during the initial infestation stages, timber species can compete successfully with the hawthorn for growing space.

CHAPTER 3

FOREST CONSERVATION MEASURES IN PROGRESS

1. Private Planting

On the Sydenham River Watershed 1,430 acres of private plantings were found in the area examined. These ranged from 1 to 25 years of age and were mostly made up of coniferous species planted on the Bothwell Sand Plain in Euphemia, Zone and Mosa Townships.

Private planting activity in the last 10 years appears to have been twice that of the previous 15-year period, with more activity occurring in Euphemia Township than in all of the others.

About half of the privately reforested areas have been planted to Scotch pine, of which 50 per cent are being grown for sale as Christmas trees. This percentage applies to all of the townships involved, with Euphemia Township being once more in the lead. The remaining sampled acreage is planted to coniferous mixtures. Various mixtures are being tried, such as: alternating rows of white pine, red pine and white spruce; white pine, Scotch pine and white spruce; white pine and red pine, and Scotch pine and Jack pine. In small acreages the combination of Scotch pine and white spruce is popular, where the Scotch pine is to be kept pruned and sold in Christmas tree form, leaving the spruce for timber production.

Various degrees of plantation maintenance were observed. The lack of properly timed prunings and thinnings appears to be the greatest maintenance problem on plantations on the watersheds. This will produce knotty and poor quality timber. Defoliation of Scotch pine by European pine sawfly (Neodiprion sertifer) was commonly observed and had obviously not been discovered and treated with insecticides.

Plantations must be cared for throughout the various stages of their development to maintain maximum timber production and timber quality. Methods include: periodic pruning, systematic thinning, treatment for insect or disease outbreaks, the replenishment of killed areas or areas of poor tree development, and periodic inspection. Like any other crop, trees need continuous attention.

2. Demonstration Woodlots

An early effort to promote good woodlot management was made by the Department of Lands and Forests when it established a number of demonstration woodlots. These were areas of private woodland on which owners agreed to follow prescribed methods of woodlot management and to permit access to the area by interested persons. Unfortunately many of these demonstration woodlots were cut over when the property changed hands or fell into neglect, so that the program has lagged.

On the Sydenham River Watershed there is evidence that sufficient pride in the operation of their woodlots is felt by many private property owners. Such properties can provide visitors with useful examples of good woodlot management. It is been recently estimated that the woodlots in the Lake Erie district produce the greatest annual per acre growth of veneer and good quality saw-log material in southern agricultural Ontario.

Ungrazed hard maple stand with good regeneration. Tours to see such well-managed woodlots, and discussions of management methods, will help the Authority's education program.

3. Tree-cutting By-Laws

Under The Trees Conservation Act of 1946 and its successor The Trees Act of 1960, 23 counties have passed by-laws to restrict and regulate the cutting of trees. These by-laws do not interfere with the right of the owner to cut material for his own domestic use, but specify certain diameters below which trees may not be cut for sale. On the Sydenham River Watershed, both Lambton and Middlesex Counties have tree-cutting by-laws. The County of Kent has not.

Better than a rigid diameter limit is the marking of trees for cutting according to their condition. Professional advice on such marking is available through the Zone Forester at Aylmer, Ontario, or through private professional foresters whose location can be obtained from the same office.

4. County Forests

Many counties have established forests under agreement with the Ontario Government. Enabling legislation for the establishment of county forests was passed as early as 1911, but was not put into effect until the establishment of the Hendrie Forest in Simcoe County in 1922. The work is done at present under The Trees Act of 1960 and The Forestry Act of 1962. These Acts provide for the purchase of lands and for their management under agreement between the County and the Ontario Government.

With the exception of one tract, all of the Middlesex County Forest lies in the Sydenham River Watershed.

5. Forest Conservation Measures in Other Areas

(a) *Authority Forests*

Agreements for establishment and management of Authority Forests, which are described in detail in the next chapter, have been drawn up between 14 Conservation Authorities and the Ontario Government. Under these agreements 60,000 acres had been acquired for reforestation and management up to December 31, 1962.

(b) *Municipal Forests*

Several municipalities other than counties have established forests which are eligible for assistance from the Department of Lands and Forests. These are useful for screening residential areas from factory areas, for water supply protection and for revenue production. The 100-acre plantation protecting the reservoir near the village of Beeton in the County of Simcoe is a good example of a municipal forest. It has been used for protection for the village's reservoir system for almost 40 years.

(c) *Tree Farms*

In the past few years a movement has been under way to recognize well-managed forest properties as Certified Tree Farms. With the sponsorship of several organizations interested in better forestry, the Canadian Forestry Association in 1953 formed a National Tree Farm Committee to recognize with a suitable

sign and certificate those owners who agree to maintain their land for growing forest crops, protect the land adequately, agree that cutting practices will be satisfactory to ensure future forest crops, and permit inspection by Committee foresters. Several Conservation Authorities have become co-sponsors of the Tree Farm movement in their areas.

It is recommended that the Sydenham Valley Conservation Authority give similar support to this movement, as there is only one Tree Farm on the watershed.

(d) *4-H Clubs*

These clubs are organized by the Ontario Department of Agriculture and Food assisted by the Department of Lands and Forests and must be sponsored by an organization interested in the improvement of woodland and reforestation.

Members must be between 12 and 21 years of age and each member undertakes a project such as marking a half-acre plot of woodland for thinning or reforesting a quarter-acre of land. For this purpose the Department of Agriculture and Food furnishes $3.00 per member and the sponsoring organization $1.50. Winners may enter the Provincial Inter-Forestry Club Competition.

It is recommended that the Authority co-operate with the provincial departments concerned in fostering forestry work in 4-H Clubs in the watershed.

CHAPTER 4

FOREST CONSERVATION MEASURES REQUIRED

Improper land use and neglect on the Sydenham River Watershed have created a considerable acreage of idle land. Such land tends to be invaded by weeds and hawthorns. Gullying along the main river banks and the tributary system is also a common condition.

1. Authority Forest

In view of the conditions described, a Sydenham Valley Conservation Authority Forest should be established in the area. Since land in the whole watershed has considerable value for agricultural production, the reasons for designating certain areas as suited for a public forest should be stated.

Some areas on the watershed contain a high percentage of forest cover, plus a limited amount of idle open land which will not in itself support economic farming. Properties of this type are better kept in profitable forest production, while agriculture is intensified on the developed open areas that lack only efficiency in the improvement and yield of crops.

In the main stream region, gullies are narrow with steep banks and do not extend far back from the river. As the areas involved are not large, such banks can be reforested through encouragement of private reforestation without public acquisition of these lands.

In the upstream areas, however, the gullies change form to one of widened flood plains and low banks. These conditions tend to cover more property and can be controlled by creating larger forest areas on them. Between the recommended blocks, where the gullied area becomes narrower, gullying can be controlled by private reforestation promoted by the Authority.

Using such a system may involve the purchase by the Authority of some areas of productive farmlands adjacent to gullied sections. Where the Authority finds it advisable to keep these farmlands in agricultural production, it may resell those parts not threatened by gullies or may use them on a rental basis to demonstrate proper land use practices.

The total area recommended for acquisition as an Authority Forest amounts to 8,577 acres. It is mostly to be found on the sand plain regions. The main recommended forest blocks are named from the town or village nearest to them and the remaining scattered properties are described as "Other Forest Areas".

(a) *Strathroy*

This is an area of 2,498 acres south and east of the Town of Strathroy on the Caradoc Sand Plain. Upstream gullying and poor care of natural woodlots are parts of the problem in this section of the watershed. Within these properties, the relatively poor pastures adjoining the woodlots are idle and should be reforested.

(b) *Newbury*

This is an area of 2,910 acres on the Bothwell Sand Plain in Mosa and Euphemia Townships. It is characterized by natural woodlots on poorly drained sandy land. Several poorly managed forest plantations are to be found in the

recommended sections so that a high percentage of the recommended land is already covered by some form of forest. Idle open areas on the recommended properties should be reforested. Parts of Middlesex County Forest are in this vicinity and demonstrate the type of forest management required.

(c) *Shetland*

This is an area of 2,910 acres on the Bothwell Sand Plain in Mosa and of Shetland. With exception of 100 acres, this recommended section is a connected series of blocks of about 100 acres each, adjoining a small tributary of the Sydenham River. They are recommended as potential Authority Forest for gully control and better land use.

(d) *Other Forest Areas*

These are scattered properties totalling 2,669 acres, mainly in Zone and Euphemia Townships between the Shetland and Newbury sections. Most of these properties present a forest management problem, such as: poor quality Christmas trees; hawthorn invasion; poorly cared for woodlots or reforestation in need of care, coupled with a certain percentage of weedy, idle open land. Since their agricultural potential has been reduced by lack of care, these lands are better suited to proper timber production as part of an Authority Forest.

Similar scattered properties exist west of the main area recommended for Authority Forest establishment near Strathroy.

There are a few cases where forest properties in the recommended areas are already being properly managed by private owners. These properties need not be acquired at the present time, but the Authority should be alert to acquire such lands if changing circumstances threaten the destruction of these woodlands.

2. Private Reforestration

On many farms, even in the better farming areas, there are small tracts which, because of steep slopes, stoniness or poor drainage, would be better in tree cover. These areas have not been privately reforested heretofore because the owner has some other minor use for the area, because he is discouraged by the long period between planting and harvest of a forest crop or, more commonly, simply because of inertia on his part.

Such areas exist on the Sydenham River Watershed, particularly on the major gully system of the river and its tributaries. Because control of this erosion is necessary, the owners of these open areas should be encouraged to reforest them. Since difficulty in establishing plantations on these areas due to slope and soil conditions may discourage the owners, the provisions of aid in reforesting such areas is of major concern to the Authority.

The main areas requiring private reforestation in connection with these gully systems appear on the principal forestry map of this report. This should direct the Authority's attention to the most critical areas.

It should be noted that this treatment has been kept within the bank boundaries so that the fields adjacent to the top of the banks are kept in crop production.

Undoubtedly there will be cases where the flood plain is too narrow to make an economic pasture unit and is therefore better reforested. In such cases, the species should be those than can endure periods of inundation by flood waters.

Bare valley slopes should be reforested before the gullies deepen.

The interest of private owners in reforestation may be fostered in several ways. Public education, such as that now carried out by the Zone Forester in the district, can be furthered by the Authority. In addition, direct assistance to private planting can be given. Several other Conservation Authorities have purchased tree-planters which supply a planting service to private owners at a nominal cost. Where rough ground makes hand planting necessary, some Authorities refund $10 per acre if inspection shows that planting has been done carefully and the plantation is adequately protected from livestock. Where labour conditions permit, the Authority might itself organize crews for hand planting on these sites.

The Department of Lands and Forests charges $14 per thousand for Scotch pine and $10 per thousand for other planting stock. For some years trees were distributed free. Following the end of the war in 1945, the nurseries were unable to meet the greatly increased demand, and it was felt that a charge for trees would ensure more care in ordering the required amount and in planting the trees received.

The assistance schemes carried out by other Authorities have stimulated interest in private reforestation while still ensuring the good use of the planting stock. It is recommended that the Sydenham Valley Conservation Authority adopt a similar scheme and concentrate its private assistance efforts in the areas described.

3. Forest Research

Detailed scientific research is the task of universities or government departments with greater research facilities than those available to a Conservation Authority. Large-scale application of proven methods is the task of private owners or of the Department of Lands and Forests. However, there are many possibilities for small-scale investigations which are urgently needed and which the Authority might encourage on its own land or on private land under agreement. Determination of the best planting methods on difficult sites such as valley slopes, compari-

son of growth in different plantation mixtures, investigation of the value and cost of culivation in plantations and the actual improvement in woodlots following thinning or other treatment, are all projects which would guide the people of the watershed in managing their own plantations and woodlots. The Authority should encourage such investigations and co-operate with the Department in carrying them out.

4. The Authority and Conservation Education

Many agencies at present do, or can, engage in conservation education. The Authority can supply opportunities and materials to encourage and enlarge these activities. Wall maps, literature, conservation pictures and conservation lectures supplied to the schools will help to give geography, history and conservation practices a local significance. A library of slides on local conservation problems and accomplishments would be of great assistance to speakers. Organization of public meetings and contact with individuals and groups such as farm forums will gain support for both private and public conservation efforts. Landowners should be encouraged to make greater use of the services available from the Conservation Authority and from officers of the Department of Lands and Forests and the Department of Agriculture and Food.

The most effective educational activity is actual participation in, or field observation of, conservation projects. Tree-planting days, group visits to well managed woodlots and conducted tours over a well organized conservation trail could all be sponsored by the Conservation Authority. These activities would all stimulate individual action on forest conservation measures, such as those described in the following chapter, which cannot be carried out directly by the Authority.

CHAPTER 5

FURTHER CONSERVATION MEASURES REQUIRED

1. Woodland Management

The woodlot inventory taken from the examined woodland areas of the Sydenham River Watershed indicates that natural woodland has received more good management, generally, than in many other areas of southern agricultural Ontario. However, good woodlot management still has to be made a common practice in every woodlot on the watershed. For the application of the general principles of woodlot management, a free advisory service is available from the Zone Forester.

A common problem is the immature hardwood stand which should be thinned. This focuses attention on one of the most difficult problems confronting the private owner in the management of his woodlot: the utilization of small woodland products which can be made and handled by the owner. These products, such as: fuelwood, pulpwood, bolts, posts and poles, if properly harvested, increase the productivity of the woodlot and the gross returns per acre. The volume of these small products thrown on the market would be reduced by diameter limit regulations which restrict the wholesale slashing of woodlots. Nevertheless, much material of this type could still be produced from thinnings and improvement cuttings and from limbs and tops of trees. The difficulty of marketing low-grade materials can seriously hamper owners in carrying out the needed improvement work in their woodlots. Any means for using small and poor-grade wood should be developed to the fullest extent.

Two charcoal manufacturers in the Thamesville and Bothwell areas are processing all types of wood. The Authority should investigate the possibility of getting more wood to these industries from the materials taken from woodlot thinnings.

Another possible outlet for small and poor-grade wood is the manufacture of wood chips in the woodlot by means of a portable chipper. Such chips can be used for the manufacture of pulp for paper, and as cattle bedding and chicken litter which can subsequently be spread on fields to increase the humus content of the soil. Chips can be made from any species of wood, and tops and branches can be utilized. The number of pulp companies which can use hardwoods is limited, and only those making kraft paper can use chips containing bark, but the demand for hardwood chips will increase and portable barkers are being developed.

Owners of large woodlots might be encouraged to undertake thinnings and improvement cuttings if equipment or trained crews were available at reasonable cost. The Authority should consider offering such a service. As an alternative, the Authority might offer a subsidy for each acre improved to its specifications and found satisfactory on inspection by the Authority's officers.

2. The Forest and Livestock

The grazing of woodlots is one of the greatest causes of woodland depreciation on the farm today. This method of livestock husbandry produces automatic and continuous loss of regeneration and, eventually, can expose the mineral soil of the woodlot.

The lack of repaired fences or loss of proper pasture due to weather conditions is the usual reason given for using woodlots as pasture. However, it is not uncommon to find woodlots deliberately used as an integral part of a pasture rotation system, with cattle fenced into parts of them.

The economic fallacy of grazing the farm woodlot has been proven in Richland County, Wisconsin. Over a five-year period, it was shown that unimproved pasture will produce over five times as much (dry matter) feed as woodland, and that improved grass-legume pasture will produce over 11 times as much feed. Woodland pasturage is considered by agricultural leaders to be only half as effective for animal nutrition as proper pasture. This is because of the lowered food value of grasses grown in shade, plus the added factor of weeds which are usually prolific in wooded pastures.

Field observations in Ontario indicate that cattle prefer the more economically desirable species, such as: maple, basswood and elm, whereas the undesirable species such as: ironwood, dogwood and hawthorn are grazed only as a last resort.

Compaction by livetock, particularly on clay soils, makes seedling survival and growth difficult. It also breaks up the protective litter layer, exposing the mineral soil to drying and thereby reducing germination. Consumption of the vegetation reduces the volume of new litter available to keep the soil open and porous and in a highly absorptive state. Thus water relations are changed, adversely affecting the rate of tree growth and natural regeneration.

Cattle break young trees to graze on them or to brush off flies. This has a particularly damaging effect in young pine plantations. Sheep interfere with pine seedling growth by nipping the buds. Hogs can ruin either natural or planted woodland by grazing and scuffing the roots. This allows fungal infection as well.

There are, of course, secondary benefits to the livestock from access to wooded areas. Those include: shade, shelter from severe weather, protection from "face flies" and "shipping fever" causes, and quiet seclusion for the delivery of their young. The better condition of stock enjoying these facilities is a real economic gain to the farmer. However this gain can be secured by fencing off a small corner of the woodlot or by developing groves or shelterbelts of fast-growing trees. The remaining woodlot is thus left to continue production, unimpaired by grazing.

Damage resulting from needless grazing varies according to the size of the woodlot and the number of animals grazed in it. However, regardless of either of these conditions, continued grazing virtually ruins a woodlot, since it removes the whole suceeding stand whose growth is needed to replace the older trees as they die or are removed. The total growth period of a woodlot is beyond the life-span of the property owner, making it difficult for him to appreciate his loss through grazing. Nevertheless, the loss remains, often in the hands of the owner's heirs. After a time, with no new growth to replace larger trees which die of natural causes, the canopy begins to open up. Sunlight then dries out the soil, weeds and grasses gain a foothold and a sod begins to form. In general, tree seeds which germinate cannot compete with an established grass cover. Eventually the trees disappear, leaving a rough, weedy pasture which cannot be improved without great difficulty.

Woodland grazing affects more than the growth of trees. Soil erosion in the woodland increases as the absorptive capacity and mechanical protection that litter affords are reduced. The open canopy exposes the soil to the erosive force

of rain, and compacted soil forces overland movement of water. Livestock tend to follow trails in the woodland and these often become centres of serious erosion. Thus, continued grazing increases surface run-off and soil erosion.

The case against woodland grazing is summed up by the United States Department of Agriculture Yearbook on Soil for 1957:

> "Investigators also agree on the low quality of the forage usually produced under hardwoods. Forage volumes are very low, except in open stands . . . and even there they seldom exceed 500 pounds an acre. Cattle thus reap little benefit, except shade and exercise, from grazing a hardwood forest — and the farmer ends up with a poorer woodlot for timber production and watershed protection."

From the public point of view, therefore, the practice should be discouraged. The Authority is therefore justified in carrying out a vigorous campaign of education in woodland improvement and also in offering direct assistance to woodlot owners. It is recommended that the Authority, through discussions with woodlot owners, should develop a program which will help eliminate the practice of woodland grazing.

3. Forest Fire Protection

Many people are unaware of the harm caused by fire in the woodlot. It is obvious that young growth and small trees are burned by surface fires; less obvious, however, is damage such as the destruction of humus. When humus and ground cover are destroyed, the sun and dry winds remove the moisture required for tree growth, and plant nutrients are destroyed. The heat of the fire also injures the growing tissue inside the bark of older trees, exposing the wood to attack by insects and fungi. In time, the wounds may be completely healed, but the damage shows up as defects when the tree is cut for lumber.

The best assurance of fire prevention is an enlightened public. The farmer can prevent most fires in farm woodlots if he exercises the same care that he does around his home and buildings. It is important to exercise such care in areas which have been cut recently, since the accumulation of slash creates a serious fire hazard. Close utilization of tops, and the scattering of slash so that it lies close to the moist ground and rots faster, will help to reduce this danger.

It is recommended that the Sydenham Valley Authority set up a committee to determine the best method of providing fire protection for public and private lands; through the co-operation of the Department of Lands and Forests, for the protection of woodlands in the Authority area.

4. Protection from Insects and Diseases

In projects such as the public and private reforestation recommended for the Sydenham Valley region, consideration should be given to the prevention of outbreaks of insects or tree diseases, and adequate arrangements made for the application of control measures. While it is not possible to predict accurately the course insects or disease may take under the ever-changing conditions of a newly forested area, there are a number of fundamental principles which, if applied, will greatly lessen destruction.

Large areas of one kind of tree present ideal conditions for an outbreak of insects or fungus disease. Mixing species in the plantation or separating the species in small blocks tends to slow the spread of outbreaks until natural agencies bring them under control, or direct control measures can be applied.

It is important to plant only the species of trees suitable to the site and existing growing conditions. Healthy, vigorous trees are certainly more resistant to attack than weak, struggling ones.

Over-mature and dead trees should be removed, as these harbour bark-beetles and wood-boring insects which may become excessively abundant and attack healthy adjacent trees. Fungus infections may likewise spread from such sources.

Care should be exercised to prevent ground fires. Even light ground fires are frequently followed by severe outbreaks of bark-beetles and wood-boring insects and fungus infection at the base of the tree.

It is essential that an inspection be made each year so that any abnormal increase in insects or disease may be noted and control measures initiated before the outbreak becomes serious. Prompt action may reduce control measures to a comparatively easy task and confine damage to a small area.

(a) *Some Important Insect Pests*

The White Pine Weevil has caused serious damage to plantations by attacking the leading shoots of young white pine. As this insect prefers to work in full sunshine, white pine should be grown in a mixture with some other species which will shade the pine in its early years. Chemical control by spraying at the proper time of year is now being used with some success. Another method now being tried, mostly on agreement forests, is "leader clipping". In this method, white pine leaders that contain living larvae are clipped off at the base, in order to prevent the larvae from developing into the moth stage. This method is designed to lower the number of egg-laying moths of this species.

In recent years, the European Pine Shoot Moth has increased to serious proportions in red and Scotch pine. Investigations are underway, but no simple and effective control measures have yet been discovered. Another enemy of Scotch pine, the Root-Collar Weevil, has recently caused serious damage in some plantations in Ontario, but not in the Lake Erie district. This insect kills young trees by girdling them below the ground. Certain insecticides applied around the base of infested trees are said to give good control.

Two other weevil species, the Northern Pine Weevil and Pales Weevil, have more recently become troublesome in concentrations of Christmas tree plantations. Therefore, the efforts to control such insects by the Authority should be kept up-to-date.

Leaf-feeding insects may kill conifers by complete defoliation, and hardwoods by defoliation for three years in succession. However, even partial defoliation may so weaken trees that they will be attacked by other enemies. This is the kind of attack against which spraying is most successful.

On those areas examined in the Sydenham River Watershed, the most common insect damage discovered was that of defoliation by European Pine Sawfly (Neodiprion sertifer) in Christmas tree plantations.

Since investigations of forest insects are constantly underway, the owner considering insect control should always check with the Zone Forester to find the most effective methods now in use.

(b) *Tree Diseases*

The chief diseases of the hardwoods are the various trunk, butt and root rots and chronic stem cankers, which are all endemic and may cause serious damage under aggravating conditions. In the Sydenham area, many woodlots containing old timber are in need of heavy preliminary salvage and sanitation cuttings as a result of mismanagement, or require cleanings and improvement cuttings designed to improve the composition and structure of the stands. When a sanitary condition is established, normal care should maintain it and obviate loss on account of decay.

The wood rots are commonly thought of as diseases of mature and over-mature timber, but experience has shown that infection may occur at a very early age. In hardwood sprouts the stem may be infected from the parent stump. In older trees infection is chiefly through wounds, either of the root or trunk, which may be caused by fire, insects, meteorological agencies, trampling by animals, or by carelessness or accident in felling and other woods operations.

For many reasons "cleanings" in the reproduction are desirable, especially where the woods have been heavily cut. Besides favouring the valuable species, those stems which are of seedling origin should be favoured over stump sprouts which are more liable to decay.

In harvest cuttings, which should recur at frequent intervals, the permissible volume alloted should include trees in which incipient decay is discovered and so far as possible those which have become a poor risk through injury or other circumstances.

Dutch elm disease, which causes rapid wilting and death to all native elm trees and most introduced species, has caused great concern ever since the first discovery in Canada in 1944. It appeared first in Quebec, then at Windsor, and has subsequently spread over a large part of Southern Ontario, including the Sydenham River Watershed. It may attack single trees or destroy whole woodlots. Evidence of the disease was frequently found on the watershed during the survey period.

This elm stand has been ruined by Dutch Elm disease. A removal and sanitation program might have prolonged its life.

Control is achieved by elimination of diseased trees and material, by meticulous sanitation, and by spraying healthy trees to prevent attack by the elm bark beetles that carry the disease. For valuable trees in parks and along streets, costs of control are well within reason.

5. Windbreaks and Shelterbelts

In the process of clearing land for agriculture, woodlots and belts of trees along fence lines have been removed; these had served as natural shelterbelts. The restoration of these in the form of windbreaks is essential to a complete conservation program in many parts of Southern Ontario.

When proper species are used and windbreaks are correctly placed the effects are almost entirely beneficial. The effects may be direct or indirect, but in either case are the result of reduction in wind velocity. The effects of windbreaks on crops and cultivated fields may be listed as follows:

(a) *Direct Effects*

(1) Wind damage and lodging in small grains and corn is reduced or eliminated.

(2) Snow and the resultant moisture are more evenly distributed over fields, particularly on the higher spots where they are required most.

(3) Wind erosion of the soil is minimized.

(b) *Indirect Effects*

(1) Moisture loss by evaporation is reduced.

(2) Temperatures in the fields are raised, which may prevent frost damage, accelerate growth and even lengthen the growing season slightly.

(3) Erosion of the soil by water may be reduced by its more even distribution when released from snow.

Belts of trees consisting of one or two rows are usually called windbreaks, and with more than two rows, shelterbelts. In Southern Ontario windbreaks as a rule give sufficient protection except where wind erosion of soil on rolling land is severe, when shelterbelts may be required. On level land, windbreaks may nearly always be established along existing fence lines, but on rolling land, consideration should be given to the contour of the land. The prevailing winds in Southern Ontario are generally from the west, so that the greatest protection will be derived from windbreaks on the west side; but the placement of windbreaks on the other three sides should also be considered.

Under certain circumstances windbreaks may cause air stagnation, which may increase temperature and moisture conditions to a dangerous degree in summer or increase frost damage in spring and fall on small areas, particularly in hollows. Where this is likely to occur, windbreaks should be planted to guide the flow of air past such spots. Where these conditions develop after the windbreaks are established, they may be relieved by a judicious opening of the windbreaks.

On the Sydenham Watershed, many types of windbreak and shelterbelt have been grown as the woodlots of the area have been cleared away for agriculture. In many cases, the typical trend of woodlot location on the watershed, on the rear boundary line, has resulted in insufficient overall protection from wind; and buildings and fields have been left exposed as a result of great spaces in this woodlot pattern. Therefore, the use of windbreaks and shelterbelts is vital.

Well-placed windbreaks aid agriculture by reducing the effects of wind erosion and frost.

However, the use of windbreaks and shelterbelts in a largely agricultural area requires that the spacing of tree species and methods of management be designed to fit the type of agriculture being employed. The species of trees used must also be adapted to the site.

For livestock farming, initial plantings of fast-growing trees followed by the planting of slower-growing but sturdier varieties in the spaces left, is a useful plan. It is sometimes found that animals tend to gather in the immediate lee of such shelter, thereby concentrating their manure too much in one spot. Pruning the bottom 6-8 feet of the windbreak will force the livestock to disperse over the field, and yet will still provide the necessary shelter.*

In areas where "cash cropping", particularly for vegetables on muck lands, is important, the planting of primary windbreaks on field borders and secondary windbreaks within the field is important to prevent the lifting of whole crops by wind.†

Experience has shown that windbreaks are an asset to any farm, that their adverse effects, if any, are local and easily remedied, and that in many areas they are essential to the control of soil erosion by wind. It is therefore recommended that the Authority encourage the establishment of windbreaks by private owners.

*British publication "Farm and Country", 1960.
†"Climate Near the Ground", R. Geiger.

6. Snow Fences

In the climate of Southern Ontario snow drifting may cause much inconvenience and sometimes hardship. Control can be readily affected by means of windbreaks and is dependent on proper placing with reference to lanes of travel and topograpic features.

Where space is limited or land valuable, lath or board fences are frequently used, but the annual cost of erection, removal or maintenance of these can be eliminated by using trees as permanent windbreaks or shelterbelts.

The object of a snow fence is to mechanically reduce wind velocity near the ground in such a manner as to cause a drift to form where it will be least harmful.

A wide belt of trees which will accumulate a large drift of snow on its windward side may be planted to the very edge of the road, the windward edge extending back a distance equal to three or four times the height of the trees and generally at least 100 feet.

In some places the snow trap type of windbreak is effectively used. It is composed of one or more rows of trees close to the road with a wide opening to windward and then a single row of trees. The single row arrests the first force of the wind and the snow is deposited in the opening. This has the advantage of requiring fewer trees than the shelterbelt and leaving the ground between open for cultivation in the summer.

Poor placement of windbreaks may accentuate drifting conditions. A single row of trees, unless it is a dense coniferous type, is seldom dense enough to completely stop winter wind, and may create drifts. Any prejudice which may exist against windbreaks for protection against drifting snow on roads arises from such poor or poorly placed windbreaks. If a windbreak has openings in it or if it ends abruptly, streamer drifts will form. Windbreaks should be kept dense and tapered down at the ends by using progressively smaller species of trees and shrubs to prevent the formation of streamer drifts.

Trees are being used successfully as snow fences in Ontario by the Department of Highways, by railways and by a number of counties. Every encouragement should be given to the establishment of such snow fences in place of the removable type of lath fence now in use.

CHAPTER 6

MARKETS AND MARKETING

Improvement of woodlots and planting of unproductive areas, as discussed in earlier chapters, are obvious means of increasing wood production. In addition, any woodlot owner should know how to efficiently harvest and market his present production.

The breadth of the market varies greatly with quality. For high-grade products, such as veneer logs, buyers will come 100 miles or more. For low-grade logs, 20 miles may be the limit, and often it is difficult to find a buyer at all.

This difficulty applies to all low-grade or small material, which the owner should remove to improve the growth of quality material in the woodlot. The market for fuelwood has declined sharply in the face of competition from other fuels, but this use still remains of some importance. A pulpwood market for thinnings now exists. Recent advances in the pulp and paper industry have made it possible for some mills to use hardwood thinnings. This type of market does not promise large returns to woodlot owners, but it does promise to defray the cost of woodlot improvements which will allow the progressive owner to produce the quality products from which his real profits are derived.

1. The Timber Harvest

Harvesting of timber involves four operations: estimation of volume, cutting, skidding and hauling. The owner may perform all operations, selling his logs at the mill; he may cut and skid the logs, selling them at the roadside; or he may sell his timber on the stump.

(a) *Estimating*

Estimation of timber may be done either in the tree (cruising) or in the log after cutting (scaling)

Some operators cruise timber by rough ocular estimate; that is, by walking through the bush and estimating, on the basis of past experience, the number of board feet in the stand. The most accurate method would be to measure each tree, consider taper and defect, estimate and tally its volume. In large wooded tracts only a representative sample, say 10 per cent or 20 per cent, may be measured and the total estimated from this sample.

One example may illustrate the value of a tallied cruise. Some years ago, in competitive bidding for 87 acres of woodland, one operator estimated a stand by tallying every merchantable tree, to be 700,000 board feet; the chief log buyer for a large furniture manufacturer estimated 350,000 board feet; another operator estimated 100,000 board feet. The actual cut from the stand was 746,000 board feet. Obviously such discrepancies are of concern to the seller as well as to the bidder who tries to maintain his place in competitive buying. Before selling standing timber, it would pay the owner to make a tallied cruise or, if necessary, to hire professional assistance for this purpose.

Similarly, when selling logs, the owner or his agent should assist in their meaurement, try to understand the allowance which must be made for defects and assure himself that he is being fairly treated.

(b) *Cutting and Skidding*

In a typical hardwood operation, the value of logs at the roadside may be half as much again as that of logs in the standing tree. The difference is mainly labour cost.

By performing the operations of cutting and skidding, the farmer increases his return by selling his labour and use of his equipment instead of just his stumpage. The flexibility of woods work in fitting into otherwise slack seasons on the farm should make this increased return particularly attractive. In addition, the farmer doing his own cutting is best able to determine that the right trees are removed and damage to the remaining stand kept as low as possible.

(c) *Hauling*

Truck-hauling has increased the distance from which mills can secure their logs. Cost per thousand board feet hauled depends largely on distance. Thus while grade 1 logs might be hauled up to 50 miles, the lower value of other logs might limit practical hauling distance to 15 or 20 miles.

2. Timber Sales

(a) *Outright Sale of Woodlot*

Frequently a sawmiller finds the simplest procedure is to buy the woodlot or farm outright. In this case, the former owner has no further interest in the land. The practice of slashing such woodlots and leaving them to become tax-delinquent is legitimate cause for community concern. Where tree-cutting by-laws are rigidly enforced, this abuse should be kept under control.

(b) *Sale of Cutting Rights*

Under this method the owner sells the right to cut all timber of certain species down to a certain diameter; or the trees to be cut may be marked in advance and the sale made on this basis. Often only a very vague word-of-mouth agreement is made and misunderstandings are common. A single written agreement would avoid this confusion.

A lump-sum method of payment is often used on such sales, based upon a volume estimate by the buyer. As mentioned in the section on cruising, the volume estimates of different bidders may vary considerably. The seller is therefore advised to consult the list of buyers of woodland products in the hands of the Zone Foresters and to obtain competitive bids from as many buyers as possible. On lump-sum purchases the buyer takes all the risk as to accuracy of estimates and quality of timber.

Selling the standing timber at a rate per thousand feet removes the uncertainty of volume estimates and requires measurement of the logs after cutting. Two uncertainties remain — the log rule to be used in measurement and the assignment of logs to different grades which differ in prices per thousand board feet. For Provincial Government transactions the new Ontario Log Rule is now required, but for private sales there is no set standard, the Doyle Rule being most commonly used. The general adoption of the more accurate Ontario rule in timber transactions would be much in the interest of private timber owners on the watershed. The woodlot owner seldom knows the problems of processing logs into lumber sufficiently well to understand fully why the buyer assigns some logs to lower grades. Publication of price lists and grade specifications by log buyers would promote

better relations with woodlot owners. Possible arguments and ill-feeling over these matters are factors in making some buyers prefer lump-sum purchase. The woodlot owner must decide whether to accept volume and grade risks in the hope of getting a better price by selling on a log measurement basis.

In the event that he chooses to be paid on a volume-removed basis, just what the buyer intends to cut and pay for should be absolutely clear. Only the best trees might be removed, and it is possible that only the best logs from these trees might be taken. This leaves the owner with many poor-quality logs which he cannot readily sell and with some poor trees standing which he wanted cut. The volume actually paid for might be small, and the woodlot owner's total realization on the transaction might be less than he would have received had he accepted payment in a lump sum.

No matter which of these two methods is chosen, a written Timber Sale Contract should cover the transaction. It should set forth all the details necessary as to prices, species, sizes, rights granted to the buyer, limiting date, times of payment and so on.

(c) *Owner-Made Logs*

The woodlot owner who has decided to realize not only the value of his woodland product but also the additional labour income derived from its harvest prefers to take payment at a price per thousand board feet for logs placed on skids at the roadway or logs delivered to the mill. Here again the securing of competitive bids and a clear understanding with the buyer regarding log grade will avoid any feeling of unfairness in the deal. An owner who simply arrives at the mill with a load of logs may feel that he has to accept the offered price even though he is dissatisfied.

3. Attempts at a Solution of the Marketing Problem

Orderly marketing of woodland products is to the advantage of the woodlot owner, the sawmill operator, and the ultimate industrial consumer who requires definite quantities of certain species in certain grades to carry on his manufacturing business. The following attempts at improved marketing may suggest methods which could be applied in the Sydenham Valley.

(a) *A Marketing Experiment near Doon*

During the winter season of 1948 and 1949 the Department of Lands and Forests in the Lake Huron District carried out an experiment in the marking and marketing of timber in an 18-acre woodlot near Doon.

The mixed uneven-aged woodlot contained considerable large white pine and red oak. Initial investigations by the Department showed growth stagnation due to over-stocking and recommended the removal of certain trees. Removal of selected trees allows the remaining trees to grow at an increased rate. As growth again slows down, another cropping should take place. This is the simple principle of selective logging—the removal of accumulated growth periodically to keep the stand healthy and productive.

Upon explanation of the proposed marketing assistance, the woodlot owner entered into a signed agreement with the Department as a co-operator, agreeing not to sell or allow to be cut any trees except those marked.

Each tree marked for removal was blazed at breast height and below stump height, the stump blaze being branded to detect any unauthorized cutting. The

Alternate cleared rows in a well-managed twenty year old white and red pine plantation are used for slash disposal.

total log scale estimated for the 223 trees marked was 47,600 board feet, Doyle Rule. The trees were listed as to species and diameter on a mimeographed form.

All the estimation data were turned over to a timber agent chosen by the Department. The timber agent entered into a written agreement with the owner to:

(1) Solicit tenders from buyers:
(2) draw up a timber sale contract protecting the owner;
(3) check on cutting operations, and
(4) measure and collect payment for all wood cut, before its removal from the property.

The agent was to receive a percentage commission of the gross value.

The timber agent mailed the volume estimate sheets to all local log buyers, giving location of the woodlot and inviting inspection of the bush.

The timber sale contract set forth the prices agreed upon for the different species, required that tops be worked into 4-foot wood to be paid for at an agreed price per standard cord, provided penalties for the cutting of unmarked trees and required that the woods operation be conducted with a minimum of damage to the woodlot.

Prices realized by the owner were much better than the average paid in the area. Prices per thousand board feet, Doyle Rule, for the standing timber were:

White and red oak	$62
White ash, soft maple, hard maple, basswood and cherry	$60
White pine	$55
Hemlock	$45
Beech	$30
Fuelwood	$4 per standard cord

The experiment was considered very successful by all the parties concerned, yielding about 2,000 board feet more than estimated, and the woodlot has been left in fine growing condition with an expected second cut in 15 or 20 years of 25,000 board feet.

(b) *The Lanark County Co-operative*

This co-operative was set up by a group of woodland owners in the County of Lanark in March 1950. Its objective is the better management and more profitable marketing of privately-owned woodland.

To put the woodland enterprise on a paying basis, it is necessary to market not only the material suitable for lumber manufacture and special products such as veneer, but also the inferior products such as the poorer hardwood species, low-grade hardwood logs of the better species, small softwood products such as cedar posts and poles and that material removed in improving a woodlot during what may be called sanitation cutting. It was felt that co-operative action in the field of marketing would best solve the problems of the woodlot owner, particularly in respect to inferior or small products. Acting as a group, they can hope for recognition by the buyers in the area as a stable source of the various woodland products.

The establishment of the co-operative followed an extensive educational campaign carried on by fieldmen of the Federation of Agriculture, the Department of Lands and Forests and the local Farm Forum leader. Interest was aroused through moving pictures, talks at schools, local evening meetings, press releases, radio pro-

grams and public speaking competitions on woodlot management. Meetings held at Lanark were attended by officers of the Department of Lands and Forests, representatives of pulp and paper companies, sawmills and other wood-using industries, and members of agricultural organizations. Gradually a workable plan was evolved, and the Lanark Forest Co-operative was set up under a number of directors with Mr. Herb Paul as manager. As manager of the co-operative his duties entail: locating markets for the woodland products of the members, arriving at satisfactory price schedules, collecting payment for products, ensuring that products are ready or delivered at the time promised, and advising members on cutting their woodland according to best forestry practices.

The co-operative had a membership of approximately 60 in the fall of 1950. By April of 1959 the membership had grown to about 250 with an average holding per member of about 200 acres. This membership has been maintained to date and some members have become interested in becoming certified tree farmers. A lifetime membership fee is $5.00 and, in addition, the co-operative receives a commission of 5 per cent of the sales. An indication of the success of this venture is the fact that the co-operative has accumulated enough funds to make advances to producing members while wood or logs are being manufactured.

PART III - WATER

The low gradients of the East Sydenham River result in a sluggish stream flow conducive to flooding.

CHAPTER 1

DESCRIPTION OF THE WATERSHED

1. General

The watershed of the Sydenham River is situated in the south-western part of Ontario, and includes portions of the Counties of Lambton, Middlesex and Kent.

The valley is orientated in a north-easterly and south-westerly direction. Its shape is approximately rectangular, the overall length of the basin being about 60 miles with an average breadth of about 24 miles and a total drainage area of 1,052 square miles.

2. Physical Characteristics

(a) *Geology*

The geological formations of the subsurface are important to the water resources of the area, especially ground water.

The *main* bedrock underlying the Sydenham Watershed is the Kettle Point Formation of the Devonian System. Around Petrolia and Oil Springs and in some other areas, the bedrock is the Hamilton Formation. The Hamilton Formation generally lies below the Kettle Point. In a few areas around Wilkesport, the Port Lambton Beds which overlay the Kettle Point Formation are found. The bedrock is at an average elevation of 500 feet above sea level in the western portion of the watershed and rises to the east.

The Kettle Point Formation is defined as consisting of dark brown to black bituminous shale with occasional interbeds of green shale. Directly overlying the black shale is a light grey, micaceous, soft, very fissile shale with siltstone interbedded in places. This is overlain by a light grey, very fine-grained micaceous sandstone. The upper part of the sandstone is slightly dolomitic, but most of it has a siliceous cement. The shale and sandstone together vary in thickness from a few feet to 200 feet or more.

(b) *Topography*

The surface features of the area drained by the Sydenham River and its tributaries were formed mainly by the last glaciation. The East Sydenham River flows alternately through clay and sand plains, while the North Branch flows mainly through clay plains. There is little relief in these plains with the consequence that stream gradients are low, and large areas are poorly drained. The flat gradient means a sluggish streamflow which in turn is conducive to flooding.

The northern watershed boundary is formed by two moraines, while part of the western boundary is also a moraine. Changing water levels in large glacial lakes caused by the melting of the glacier formed shorelines throughout the watershed. The shoreline of the glacial lakes Whittlesey, Arkona and Warren created the divide between tributaries of the north and east branches of the Sydenham in the centre of the watershed.

3. Drainage Systems

(a) *East Sydenham River*

The East Branch, as it is commonly called, has its source near Ilderton, approximately 8 miles north-west of London at elevation 925. During its course of 100

miles to its confluence with the North Sydenham at Wallaceburg, it drops to elevation 574 feet for an average gradient of 3.5 feet per mile.

From the confluence at Wallaceburg to Dresden, a distance of about 14 miles, the gradient is less than one foot per mile; while for the next 37 miles between Dresden and Alvinston the gradient is about 2 feet per mile. For 5 miles approximately upstream from Alvinston the gradient increases to 5 feet per mile and then decreases to 1.5 feet per mile for the next 17 miles. From here to Strathroy, a distance of 14 miles, the gradient is 5.4 feet per mile. From Strathroy upstream to its source the increase in gradient is quite noticeable and averages about 13 feet per mile. The tributary system of the East Branch is extensive and evenly distributed throughout the basin. There are at least six major tributaries, all of which have a fairly well distributed tributary system of their own. These major tributaries are Long, Fansher, Haggerty, Morrogh, Brown and Hardy creeks.

East Branch of the Sydenham River immediately upstream of Dresden.

(b) *North Branch*

The North Branch of the Sydenham River has a relatively flat gradient between Wilkesport and its confluence with the East Branch in Wallaceburg. A tributary, Otter Creek, joins the North Branch near the northern boundary of Wallaceburg. At Wilkesport the North Branch divides into Bear and Black Creeks at elevation 574 feet.

(c) *Bear Creek*

The source of Bear Creek is near Arkona at an elevation of 805 feet. For its length of 66 miles the average gradient is 3.5 feet per mile. From Wilkesport to beyond Petrolia, a distance of 38 miles, the gradient is 1.4 feet per mile, but it increases to 4 feet per mile for the next 18 miles. In the remaining 10 miles to the source, the gradient increases to 10 feet per mile.

The only tributary of significant size is one without a name which joins Bear Creek immediately below Petrolia.

Bear Creek above Petrolia. During the summer it is shallow and many reaches contain considerable aquatic growth.

(d) *Black Creek*

The source of Black Creek is in the vicinity of Inwood at an elevation of 675 feet. During its course of 33 miles to the confluence at Wilkesport the average gradient is 3 feet per mile. The first 21 miles upstream from its confluence the gradient is 2.5 feet per mile, but increases to 4.3 feet per mile over the remaining 12 miles.

The tributary system is not extensive and practically all flow is from the east.

(e) *Sydenham River*

The main Sydenham River is approximately 3 miles long between its outlet to Chenal Ecarté, and the confluence of the North and East Branches in Wallaceburg. This reach of river has a very flat gradient of less than one-half foot per mile. The Sydenham River up to Wallaceburg is navigable.

The Chenal Ecarté, into which the main Sydenham River enters, is a wide and flat meandering stream. It flows between the St. Clair River, about 1½ miles below Port Lambton, and Lake St. Clair. On its way it divides into two distinct channels which meander through the large area of low swampy land which forms Walpole and St. Anne Islands.

(f) *Land Drainage—Wallaceburg*

A large area around Wallaceburg is drained into the Sydenham River and Chenal Ecarté by an extensive system of large ditches or canals and dikes. The water in most cases has to be pumped out of the canals.

CHAPTER 2

WATER PROBLEMS

1. General

In general, problems with water include: flooding, low flows, water supply, pollution and drainage. Unfortunately all these water problems exist in the Sydenham Valley Watershed and all can be classified as *major*.

2. Flooding

Flooding becomes of real significance only when the water causes, or has the potential to cause, property damage or loss of life because of residential, commercial or other development in the area.

Flood damage may be divided into two classes. First, there is the damage from inundation which "wets" materials and deposits mud and debris. The wetting causes plaster to fall from walls, floors to warp and perishable goods to spoil.

Second, there is the damage, caused by erosive water velocities, which carries away soil from around foundations. This causes settlement and can cause the structure to fail.

Physical and climatic conditions in the watershed determine the nature of flood flows.

Before the land was cleared the natural forests acted as a reservoir for retarding rapid runoff, thus reducing peak flows. Land drainage and row cropping contribute to the development of flood peaks since the natural infiltration is reduced. The development of urban centres with large hard-surfaced areas increase the peak surface runoff.

The channel capacity of the stream has been developed by the average annual maximum flow. Periodically, the watershed receives a depth of precipitation either in snow or rain which produces a much greater flow. The natural channel is then overtopped and adjacent areas are flooded.

Early settlers located many towns and villages along streams without consideration for flood potential. Many disastrous floods could have been avoided if the natural flood plain had been preserved, and if building in low areas had been prohibited.

Towns subject to flooding in the Sydenham Valley are Wallaceburg, Dresden and Strathroy.

Wallaceburg is particularly susceptible to flooding because the average elevation of the town is only approximately 6 feet above the normal river level. The confluence of the North and East Branches of the Sydenham River is located in the centre of town. This also contributes to the danger since a flood flow in either Branch can cause flooding, and coinciding flood peaks on the two branches can cause a major disaster.

Dresden, while not as vulnerable as Wallaceburg, is also subject to flooding. Here the river stage must rise approximately 15 feet before any significant flooding occurs. A large section of Dresden is situated on the lowlands within a large oxbow of the river. During a flood the water flows across this oxbow and floods a section of Dresden.

Ice and water over the highway just east of Wallaceburg (near "Peer's Corners") during the March 1927 flood.

Dresden, April 1947 — operating a row-boat on the main street during the flood.

Strathroy also experiences flooding. The cross-section of the East Branch here is small and lacks discharge capacity. The discharge capacity is further reduced by under-sized bridges and extensive fill and vegetative growth along the banks.

Accurate history of the flooding with maximum flows and stages for an area can easily be compiled if streamflow data are available for many years. If the streamflow data are not available, a limited history can be compiled from old newspaper records and local interviews to locate high water marks.

Excerpts from newspapers indicate the seriousness of floods over the past seven decades.

The Globe, Toronto, Saturday, June 4, 1892, reported:

"St. Thomas, June 3—The town itself is flooded, and the Sydenham, usually a quiet stream, is a rushing torrent. Men working on the new bridge there have had to lash the timber with ropes to trees to keep it from being carried away. It is feared that the heavy rains have done much damage to crops."

Again on Monday, June 6, 1892, the Globe reported:

"Wallaceburg, June 4—The heavy rains of the last two days in this section have caused a tremendous raise in the Sydenham River. Both branches have risen above high water marks and are still rising . . . Our mill owners and lumbermen are heavy losers as thousands of logs have gone out towards Lake St. Clair, and their recovery will incur heavy expense."

The flood of 1898 was described by the Globe, Toronto, Tuesday, March 15, as:

"Chatham, March 14 — Intelligence from Wallaceburg reaches this city tonight to the effect that the Sydenham River is terribly swollen and the flooding causing widespread damage to farmers, mill men and log owners."

In 1904 the Sydenham River caused severe flooding at Wallaceburg. The Globe, Toronto, Monday, March 28, reported:

"Wallaceburg, March 26—The worst spring freshet that ever visited this section started yesterday and is pouring down both branches of the Sydenham River at a fearful rate today and has flooded all the low lands in this vicinity, many people in town having to leave their houses. Several farmers and their families have been taken from their homes in boats, some of them having lost nearly all their livestock by drowning."

The Wallaceburg News in their "Remember When" article, March 13, 1962, noted:

"In 1904 we had the highest water crest and destructive flood which covered a large area of land with water up to 12 feet deep . . ."

In 1927 Wallaceburg was again hit hard by the flooding of the Sydenham River. Again in their "Remember When" article, March 13, 1962, the Wallaceburg News noted:

"This flood (1927) caused much damage to property, lasted about 3 days and covered our roads and streets. It was impossible to deliver milk and food except by boat."

In 1938 Strathroy was flooded by the Sydenham River. The following was reported in the Globe, Toronto, February 7, 1938:

"The Sydenham River at Strathroy rose to within 15" of its peak, 3 bridges on the Dundas District were closed, traffic and low lying fields in the easterly section of the town were inundated."

In 1947, Wallaceburg and Dresden were hit by major flooding. The north section of Wallaceburg was flooded to an elevation of approximately 581.5 feet. Thousands of acres of rich agricultural land throughout the Gore of Chatham, Chatham and Dover Townships were inundated. The inflow into the flat land around Wallaceburg is estimated at 27,000 cubic feet per second.

In Dresden the river rose approximately 20 feet above its normal level to elevation 594.5 feet. The business section immediately south of the river loop was flooded. Local resident report that the flood water flowed west down John Street.

The Toronto Globe and Mail, April 7, 1947, reported:

> "April 6, Wallaceburg and Dresden were hit hard. Damage continues to mount, flood peaks not expected till noon 7th. From 25 to 40% of the population forced to leave their homes. Water in many places is over the floors of dwellings. Residents of Dresden being rescued from second story windows. Dozens of autos under water. The fire hall and Hydro station flooded almost to the second story. Lumber valued at $10,000 washed away."

In 1953 Strathroy was hit by severe flooding. The Stratford Beacon-Herald, May 26, 1953, reported:

> "At Strathroy, most of the main streets were flooded up to two feet in some places . . ."

The following year, 1954, Strathroy was hit again by a snowmelt flood. The Strathroy Agricultural Dispatch, Thursday, February 18, 1954, reported:

> "The premature spring breakup caused by swiftly rising temperatures, heavy rains, and melting snow, caused the flash flood throughout Western Ontario leaving town streets, dug up to install sewers last year, at their worst condition.

Man stranded on the roof of his house on Metcalfe Avenue during the April 1947 flood at Dresden.

Parts of Victoria, Albert, Front, Metcalfe and Centre Streets had to be isolated because of the treacherous water hiding large pot holes. Concern was expressed over the sewer pump house which was isolated all day Tuesday. Water was too deep to wade to the small building on the banks of the Sydenham and the current was too strong for a boat."

The same year Wallaceburg had a serious flood caused by rain and snowmelt and aggravated by ice jamming in the river. The Wallaceburg News, Tuesday, February 23, 1954, reported:

"Spring weather with heavy rains on Tuesday (16th) caused a serious flood. A bit of wet snow fell at night, but Wednesday (17th) was mild with the high being about 40 degrees and sunny with a brisk wind. Blasting of the ice jam in the East Branch was carried on all night. The crest of the flood was reached Thursday morning (18th) on a sunny bright day with 50 degree temperature. Friday (19th) was similar, sunny and slightly warmer. The river had dropped almost to normal by Friday night."

3. Low Flows and Water Supply

Problems of low flow and water supply occur when there is insufficient water to meet the demand. The demand can be for one of several uses such as domestic water supply, irrigation or pollution abatement. For some uses the water quality is also of importance.

Problems of low flow and water supply are caused by lack of surface water and dropping ground water levels. Ground water levels drop when there is not sufficient natural recharge to offset the quantity of water removed by pumping.

Surface water problems normally occur during the summer and fall. On the average 40 per cent of the surface runoff for streams in Southwestern Ontario occurs in March and April. Only 12 per cent of the surface runoff occurs during the months of June through September. It is this low runoff during hot, dry, summer months that causes the problems.

In the Sydenham Valley the problem involves both municipal and agricultural water supply.

Alvinston and Dresden on the East Branch have water supply problems.

Alvinston obtains its water supply from shallow wells about 15 feet deep, which frequently become inoperative during a hot, dry summer. During the summers of 1963 and 1964 Alvinston had a serious water supply problem.

Dresden draws water from the East Branch to augment its municipal supply obtained from wells. Two wells were drilled in 1942 and provided the main supply until the late fifties when falling ground water levels necessitated drilling additional wells and using river water to meet the increased demand. Ground water recharge, using river water, has not proved successful at Dresden. If the capacity of existing wells drops or if the demand is increased, Dresden will be faced with finding new ground water aquifers or taking additional water from the river.

Considerable trouble has occurred with the river intake due to low river levels and silting of the intake. Dresden presently is looking for a solution to this problem.

The Town of Bridgen has a long history of municipal water supply problems. The town has been forced to haul water by truck at the cost of $6.00 per thousand

Low flows in the streams during the summer create stagnant, unsightly pools. The flows are not sufficient to reduce pollution.

Agricultural pollution from animal waste, fertilizer and insecticides lowers the water quality.

gallons. Bridgen's present supply is from wells located at Kimball and the water is pumped to Brigden. The use of water is restricted during the summer and watering lawns and washing cars is prohibited.

Most of the farmers in the watershed depend upon farm ponds for water for agricultural purposes. Many of the ponds have been poorly designed and are undersized, and as a result during hot, dry summers the ponds go dry. Recently, this has caused severe hardships for many farmers who were forced to haul water for livestock as well as for domestic consumption.

Low summer flows have a detrimental effect on streams throughout the watershed. Unsightly stagnant pools form in sections of the river. Pollution tends to accumulate in the pools adding to the unsightly appearance. Local fish and wildlife die because there is not a supply of clear, fresh water.

4. Pollution and Water Quality

Quality as well as quantity is important in the supply of water. At the time of this report's preparation, all municipalities located along the Sydenham River and its tributaries were dumping sewage into the stream. Towns and villages include Petrolia, Brigden, Strathroy, Alvinston, Dresden and Wallaceburg. Pollution from these municipalities will have to be corrected if a high quality of water is to be maintained in the river.

Pollution from the above noted areas constitutes a serious hazard to most reservoirs which could become contaminated until sewage treatment plants of adequate capacity are constructed.

On Bear Creek oil slicks from the Petrolia area can be found along the stream banks as far downstream as Brigden.

Sydenham River, showing erosion caused by wave action.

5. Erosion

The types of erosion found in the Sydenham Valley are: stream bank, gully, and sheet erosion.

The soil in the watershed is mostly a clay of the Brookston Series. Since it is a fine material it is easily eroded and carried by water.

Many areas along the East and North Branches and Bear and Black Creeks are subject to stream bank erosion.

Gully erosion can be found in many areas. Sheet erosion, although it is more difficult to detect, can be found by examining low areas between hills for deposits of topsoil eroded from the hills.

With erosion, valuable fertile topsoil is lost from fields. Streams carrying their heavy loads of sediment become cloudy and lose their natural clear appearance and the sediment, if the concentration is high, can have detrimental effects on the fish population.

6. Drainage

Drainage is important in the Sydenham Valley for two reasons. First, a large land area around Wallaceburg, originally lake swamp, has been reclaimed by diking and draining with pumping plants. Secondly, because of the clay, topsoil and low gradients throughout the watershed, land drainage is required for successful farming.

In general, land drainage is an agricultural consideration. However, in some cases land drainage can contribute to, or form, part of a flood control scheme. In this case drainage is a hydraulic consideration as well.

The dikes along the lower Sydenham River, in addition to their drainage function, act as flood walls during peak flows.

CHAPTER 3

HYDROLOGY

1. General

Hydrology is the science which deals with the occurrence and movement of water in its various forms upon and beneath the land areas of the globe. The term "hydrologic cycle" is applied to the general circulation of water from the seas to the atmosphere, to the ground, and back to the seas again.

The hydrologic cycle may be considered to begin with the water of the oceans. Water from the ocean surface is evaporated into the atmosphere. This vapour is condensed by various processes and falls to the earth as precipitation. Some of this precipitation falls directly on the seas, and some falls on land surfaces. A portion of that falling on land is retained temporarily in the soil, in surface depressions, and on vegetation and other objects until it is returned to the atmosphere by evaporation and transpiration. The remainder, moving by devious surface and underground channels to the rivers, lakes, and eventually to the seas, is likewise subject to evaporation and transpiration throughout its travels.

On a world-wide basis, the volumes of moisture involved in each phase of the cycle are relatively constant. In terms of a limited area however, such as a small river basin, the quantities in any part of the cycle vary through wide limits. These variations are the primary subjects of study in hydrology. For example, a temporary imbalance of the cycle in which great volumes of water are concentrated in the streams results in a flood. Conversely, small or negligible amounts of water in the precipitation phase of the cycle combined with increased evapotranspiration losses lead to drought.

In this chapter the factors affecting the hydrologic behaviour of the Sydenham Watershed are briefly examined.

Wallaceburg, February 1968: an imbalance in the hydrologic cycle can result in flood or drought.

2. Meteorological Stations

A meteorological station is a place at which meteorological data such as precipitation, temperature, wind and sunshine are collected. At present there are six stations located within the watershed. The Wallaceburg Station which began in 1905 was closed in June 1964, because of the lack of an observer. Three of the six stations are maintained by the Meteorological Branch, Department of Transport, Canada, and three by the Conservation Authorities Branch, Ontario Department of Energy and Resources Management.

TABLE 1

METEOROLOGICAL STATIONS

Station Name	Observation Program					
	Temperature	Precipitation	Periods with no change in program, location or name			
			Began		Ended	
			Year	Month	Year	Month
Meteorological Branch						
Dresden		x	1956	07		
Oil Springs	x	x	1960	09		
Petrolia		x	1883	04		
Wallaceburg	x	x	1905	01	1964	06
Conservation Authorities Branch						
Alvinston		x	1963	06		
Cairo		x	1963	06		
Metcalf Township		x	1963	06		

3. Streamflow Records

A considerable portion of precipitation is returned to oceans and lakes as streamflow. The measurement, analysis, and interpretation of streamflow data are important phases of hydrologic studies of any basin with regard to water conservation and flood control. Streamflow records give the history of flows which have occurred, indicating the time, duration and magnitude of extremes in flow. These are correlated with precipitation records for evaluating the runoff characteristics of the basin.

The types of gauges in general use are the staff and box (tape and weight) gauges which are read manually, and the automatic recording gauges operated by a float and clockwork mechanism. Manual gauges have a much lower initial cost, but require regular attendance in order to obtain an adequate flow record. Perhaps the most serious disadvantage of the manual gauge is that, without frequent observations, large changes in stage may be inadequately reported. On small streams a major flood may develop, rise to a peak, and drop back to low stages within 24 hours. One or two daily readings are insufficient to define such an event. Even on

larger streams such readings prove inadequate. Because of these facts most new installations in Ontario are of the automatic type and a continuing program is underway to replace older manual gauges with automatic ones. Automatic gauges give continuous record of river stage and thus clearly define any flood event.

For the Sydenham Watershed, streamflow records for the East Branch at Alvinston (Drainage Area = 283 square miles) have been kept from September to November, 1947, and continuously from March 1948 to the present time. This gauge has been manual throughout. A recording gauge was installed in 1964 at Wilkesport (Drainage Area = 374 square miles) just below the confluence of Bear Creek and Black Creek. Since 1962 river stage elevations have been recorded using staff gauges during the spring break-up period at the following locations: Alvinston, Becker, Dresden, Florence, Petrolia, Strathroy, Wallaceburg and Wilkesport. Such records are of great value in studying the local flood problems.

4. Floods

Floods are defined as any relatively high streamflow overtopping the natural or artificial banks of any section of a stream. However, as noted earlier, in general usage the term is slightly more restrictive, being applied only when the inundation causes or threatens damage. They are temporary imbalances created by excessive rainfall or snowmelt beyond the absorptive capacity of the ground.

(a) *Winter and Spring Floods*

Floods during the winter and spring months are caused by snowmelt, rain or ice jams or a combination of these factors. The determination of snowmelt and its subsequent runoff is a complex problem to which a complete solution has as yet not been found. The physics of snowmelt involves many factors such as temperature, solar radiation, humidity, wind speed, vegetal cover, and so on. The problem is made even more complex by the scarcity of data. The variations in snow cover are further amplified by uneven melting, resulting from differences in elevation, slope, aspect and shading. Because of these complexities the snowmelt studies are usually carried out on an empirical basis.

Snowmelt alone does not create serious flood problems on the Sydenham Watershed. The average seasonal snowfall varies from 30 inches in the south-west to 70 inches in the north-east, but the accumulation on the ground is reduced during the winter by occasional periods of melting. A snow course was established in Adelaide Township in December, 1964, to give a measure of the water content of the snow on the watershed.

Rain during the winter and spring is always cause for concern. At that time of year, the runoff potential is high and even moderate rains may produce severe floods. The high flows of February, 1954, were a consequence of just such a situation, with flooding at various locations on the watershed being aggravated by ice jams.

(b) *Summer and Fall Floods*

Floods are very infrequent during the summer and fall on the Sydenham Watershed, particularly on the main stream. This is due primarily to the higher infiltration capacity of the soil, extensive ground cover and available channel capacity at this time of year.

However, local flooding on small tributary streams as a consequence of high intensity rainfall from summer thunderstorms is not an uncommon occurrence on the watershed.

Hurricane-generated storms which produce very heavy rains have a high flood producing potential in the late summer and fall. Fortunately, these storms are infrequent over Southern Ontario. Nevertheless, the possibility of their development requires that flood control structures be designed to handle these severe conditions.

5. Design Flows

The "design flow" is the peak discharge that is adopted as the basis for the design of river control structures such as dams and channel improvements. For design purposes there are three standards which are generally accepted in evaluating flood flows. These are:

(a) *100-Year Flood*

This is defined as a flood which is expected to occur, on the average, every 100 years. In other terms, there is a one per cent chance of a flood equal to or greater than this value occurring in any year. This term does not in any way imply that such a flood, having occurred once, will not recur for the next 100 years. This flood is estimated by frequency analysis of available flow records or by the unit hydrograph approach as applied to the 100-year storm.

(b) *Regional Flood*

This flood is usually taken as equivalent to the largest flood known to have occurred over the meteorologically similar region. For a basin in Southern Ontario, Hurricance Hazel, which caused heavy flooding and damage in the Toronto area in 1954, is adopted as the regional flood. No probability can be assigned to its actual occurrence over the basin under study.

Where there is adequate storage available, reservoirs are usually designed so that this flood can be controlled within the permissible flow in the reach to be protected.

(c) *Probable Maximum Flood*

This is defined as the most severe flood considered possible on the basin. The probability of its actual occurrence is exceedingly small. Such a flood has never visited the basin in the past but has some small probability of doing so in the future. These calculations are made to ensure a very high degree of safety in the construction of dams. This flood is estimated to result from probable maximum rainfall.

6. Minimum Flows

The minimum flow of a stream enters into consideration in many hydraulic problems.

Minimum flows are subject to the same statistical analysis as maximum flows. For satisfactory analysis the flow records should be long enough to have embraced several droughts. Although this condition is not adequately met by records at Alvinston, frequency analysis of available records yields flows for various recurrence intervals.

CHAPTER 4

PLAN FOR HYDROLOGIC GAUGES

1. General

Hydrologic gauges measure one element of the hydrologic cycle in space and time. The common elements measured by hydrologic gauges are precipitation and streamflow. Some other elements measured are: temperature, evaporation, radiation, sunshine, wind, soil moisture, ground water and humidity.

In developing design criteria for a dam, long-term gauge records are desirable to determine the regime of the river. From precipitation and streamflow records, the lag time between these two elements at the damsite may be determined. Also a unit hydrograph may be derived which is useful in finding what the flow would be if a Hurricane Hazel or a Maximum Probable Storm occurred over the watershed. If long term records are available, frequency analyses can be performed which results in determining the recurrence interval for high flows (floods) and low flows (droughts).

Hydrologic records are important in setting up operating procedures for a reservoir. Past floods as well as hypothetical flows can be routed through the reservoir to give a reduced peak downstream. During the actual operation of the reservoir the precipitation and streamflow gauges are required to provide the dam operator with good forecasts of the expected flow. The operator can then adjust his gate openings to conform to the best operating conditions for the flow expected.

2. Rain Gauges

Although there are no recording rain gauges on the watershed at present, there are a number of gauges outside the watershed. Those close enough to be useful are at London, Sarnia and Ridgetown.

Six recording rain gauges are proposed to cover the watershed at about 180 square miles per gauge. This is compared with a density of about 90 square miles per gauge in the Metropolitan Toronto and Region Conservation Authority. With the gauge network proposed, any point on the watershed will be within 10 miles of a recording rain gauge.

There are six standard rain gauges on the watershed. Except for a standard gauge with each recording rain gauge no other standard gauges are proposed.

3. Snow Courses

There is one snow course on the boundary with the Ausable Watershed. Snow courses give information on snow depth and water content twice a month during the winter. These data are valuable in giving an indication of the runoff to be expected at the spring break-up.

Three additional snow courses are proposed for the Sydenham Watershed located in the middle and upper portions of the main tributary areas.

4. Stream Gauges

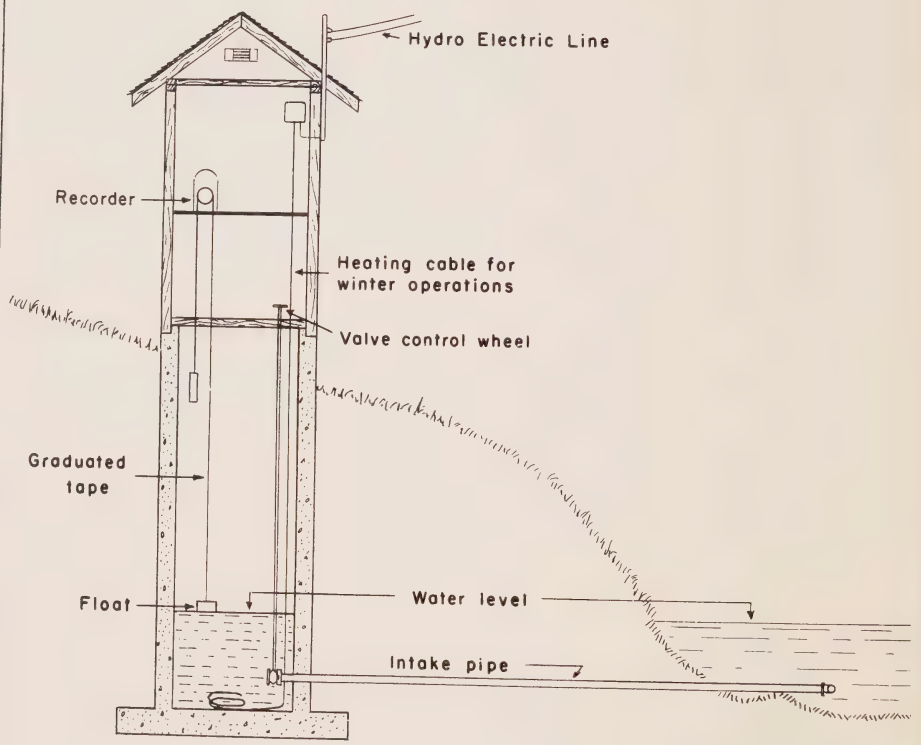
At present, there are two recording stream gauges and five staff gauges on the watershed. Recording stream gauges give a continuous record of the river stage which can be translated into flow.

Six additional recording stream gauges are proposed. These would be located on the major tributaries near their confluence with other tributaries, as well as in upstream locations, covering sub-drainage areas from 50 to 273 square miles. Near the mouth of the river, in the vicinity of Wallaceburg, the level of Lake St. Clair affects the stage-discharge relationship. Therefore, only a staff gauge is proposed for Wallaceburg downstream of the confluence. A staff gauge is likewise proposed for Otter Creek.

TYPICAL STREAM GAUGE INSTALLATION

FIGURE 4

CONSERVATION AUTHORITIES BRANCH, DEP'T. E.&R.M., L.R.L. 1965.



5. Proposed Hydrologic Gauge Network

To develop an adequate network of hydrologic gauges the Authority should initiate a program for the installation of additional gauges. This could be extended over several years.

The rain gauges can be installed by Branch personnel in less than an hour. The voluntary observer turns over his records to the Branch.

With snow courses the observer must make two surveys a month. Each course requires about 2 hours work under adverse conditions.

The stream gauges are installed under the supervision of personnel of the Water Resources Branch of the Canadia Department of Northern Affairs and National Resources. They also meter the stream monthly and publish records of the daily flows in their annual reports.

Table 2 gives the approximate location for the proposed gauges. To aid the Authority in establishing a program the gauges are listed in order of priority. It is recommended that the Authority initiate this program as soon as possible and that it be completed within five years.

TABLE 2

PROPOSED HYDROLOGIC GAUGE INSTALLATIONS

Gauge	Approximate Location
Recording Rain	
1	Lot 17, Con. X, Caradoc
2	Lot 15, Con. III, Warwick South
3	Lot 1, Con. VIII, Mosa
4	Lot 12, Con. VI, Enniskillen
5	Lot 15, Con. XIII, Gore of Camden
6	Lot 18, Con. VI, Gore of Chatham
Snow Courses	
1	Lot 17, Con. R.V.N., Mosa
2	Lot 3, Con. VI, Warwick South
3	Lot 24, Con. V, Enniskillen
Recording Stream	
1	Strathroy (Sydenham R.)
2	Petrolia (Bear Cr.)
3	Oil Springs (Black Cr.)
3	Dresden (East Sydenham R.)
5	Wilkesport (Black Cr.)
Manual Stream	
1	Wallaceburg (Below confluence)
2	Wallaceburg (Otter Cr.)

CHAPTER 5

SURVEYS AND INVESTIGATIONS

1. Watershed Inspection and Interviews

Interviews were conducted with Authority members, municipal officials and local individuals to establish the nature and seriousness of conservation problems in the watershed. In this way information was obtained on previous floods, high water marks and damages, droughts and erosion.

2. Field Surveys

These included topographic surveys at proposed dams and diversions, and differential levelling to establish bench marks at proposed sites and to determine elevations of high water marks.

Stream metering was carried out on the Lower Sydenham River, Chenal Ecarté and Johnson Channel to determine the normal flows in these channels.

River cross-sections were taken along the Sydenham River from the Chenal Ecarté to Dresden to establish the channel bottom profile.

3. Aerial Photography

Aerial photography of the Alvinston, Brigden, Petrolia and Wilkesport reservoir areas and the Sydenham River channel from Wallaceburg to Dresden was obtained under a contract which also provided for detailed topographic plans for the Alvinston and Wilkesport reservoirs and the Sydenham River.

4. Engineering Studies

The extent of the engineering studies varied. In the case of proposed dams, the studies were of a reconnaisance nature. The studies were directed to locating storage for flood control and conservation and determining preliminary costs of providing this storage. Additional field work including foundation investigations will be required before the exact location of the damline can be determined.

The water surface profiles for the Sydenham River are as accurate as can be determined with available information.

CHAPTER 6

FLOODING — WALLACEBURG AND DRESDEN

1. General

As noted in the chapter on water problems, Wallaceburg and Dresden are subject to frequent and severe flooding. A separate chapter has been devoted to flooding and floodline mapping in this area for the following reasons:

(i) the problem of flooding is extremely serious;

(ii) the floodlines will provide a guide for expected flood levels for flood warning until remedial works can be executed;

(iii) stage discharge curves are required to determine the required extent of remedial works in the form of reservoirs and diking to protect Wallaceburg and Dresden.

The identification of areas subject to flooding will be extremely helpful to the municipalities and their planning boards in preparing plans of development and zoning.

2. Past Flooding

The estimated flow at which flooding begins in Dresden is 10,800 c.f.s. The portion of flood flow at Wallaceburg developed by the North and East Branches is approximately 45 and 55 per cent respectively. This indicates that most floods in Dresden would occur at the times when flooding in Wallaceburg was severe.

Table 3 indicates the estimated recurrence frequency and flows for past floods at Wallaceburg. The flood flow at Dresden in April 1947 has been established at 13,800 c.f.s. and the flow into the flat plain around Wallaceburg at 25,000 c.f.s. The "degree of flooding" is based on the newspaper comments and the fact that the channel capacity of the Sydenham River below the confluence in Wallaceburg is only 9,000 c.f.s. Although the accuracy of Table 3 is limited, it does indicate the nature and seriousness of the flood problem.

TABLE 3

FLOOD RECURRENCE FREQUENCY AND SEVERITY AT WALLACEBURG

Degree of Flooding	Estimated Flow, c.f.s.*	Return Frequency in Years
Very Severe	33,000	75
Severe	25,000	18
Serious	15,000	12
Minor	10,000	5

*Inflow into plain around Wallaceburg from both the North and East Branches; c.f.s. = cubic foot per second.

Wallaceburg flood, April 1947.

3. Flood Control Aspects of Running Creek

The channel bottom of the ditch known as Running Creek is flat. The water levels at the point where the water enters Running Creek and at the mouth vary according to the water levels in the North Branch and the Chenal Ecarté respectively. The direction of flow in the creek depends on the level differential between the two streams it connects. With high levels in the North Branch a portion of flood water is diverted down Running Creek to the Chenal.

The discharge capacity of Running Creek has been estimated at 1,100 c.f.s. and limited by the bridge constructed across it. It therefore contributes little to the flood protection of Wallaceburg.

4. Flood Flows

The drainage area above the confluence in Wallaceburg for the North and East Branches is 460.4 and 579.7 square miles respectively, giving a total of 1,040.1 square miles. It is possible for a drainage area of this size to develop very large flows.

Due to the lack of hydrologic data it is necessary to calculate flood flows by theoretical and empirical methods. Table 4 gives the estimated theoretical flows from rain that could occur at the confluence. Some reduction to the peak flows would occur due to storage by overbank ponding, but this would be extremely difficult to calculate.

TABLE 4

ESTIMATED FLOOD FLOWS FROM RAIN FOR WALLACEBURG*

Flood	Flow — c.f.s.		
	North Branch	East Branch	Below Confluence
25 year	9,600	10,750	20,350
50 year	13,900	17,000	30,900
100 year	16,000	20,000	36,000
"Hazel"	17,500	23,200	38,600
Probable max.	36,700	50,200	83,900

*Storm centred over entire basin

Several contradictions appear when comparing Tables 3 and 4. They are caused by limited hydrologic data and the fact that flows given in Table 3 cover both rain and snowmelt floods whereas Table 4 pertains to floods generated by rainfall only. If a storm was centred over either the North or East Branch, the resulting flow for that branch could be considerably increased.

For estimating floodlines the following flows were selected:

Frequency	Flow c.f.s.	
	Wallaceburg	Dresden
1 in 25 years	25,000	13,800
1 in 100 years	36,000	20,000

The April 1947 flood corresponds to a 1 in 25 years flood.

5. Ice Jamming

As ice piles up, it reduces the free flow area and creates higher backwater upstream. The low velocities in the Sydenham River make it particularly susceptible to jamming. This condition can be aggravated if a "set-up" by wind occurs on Lake St. Clair and the river flow is reduced to zero.

The Sydenham River is a wide river and should facilitate the flow of ice. If the stream velocity is low or the outlet of the Chenal Ecarté is blocked by lake ice, jamming will develop.

It is recommended that the Authority maintain a continuous river inspection during times of flood and ice flows. If jamming occurs, blasting should be tried, if possible, to help clear the river.

6. Floodlines

(a) *Wallaceburg*

It is recommended that the Authority advise the town that existing and future development in Wallaceburg below elevation 585 feet could be subject to serious flooding unil remedial flood control measures are completed.

(b) *Dresden*

It is recommended that the Authority advise the town that existing and future development in Dresden below the 600 foot contour could be subject to serious flooding until remedial flood control measures are completed.

CHAPTER 7

FLOOD CONTROL AND CONSERVATION REMEDIAL MEASURES

1. General

The flood control and conservation remedial measures dealt with in this section of the report have been selected to help alleviate some of the problems outlined in Chapter 2.

2. Flood Control Measures

Effective flood control for an area is a problem of water regulation and land use and includes one or more of the following measures:

(a) Proper land use practices
(b) Reforestation
(c) Reservoir construction
(d) Channel improvements and diversions
(e) Dike and flood wall construction
(f) Zoning
(g) Flood Warning systems

The proper use of the land and the reforestation of marginal and submarginal land can greatly retard the surface runoff. This helps to reduce flooding. Recommended agricultural and forest practices for land in the Sydenham Valley have been given in the conservation report on "Land and Forest", issued in 1963.

3. Degree of Flood Protection

The degree of flood protection provided is largely a matter of economics. The cost of protection must be weighed against possible flood damages. The degree of protection is a matter of policy for the governing agency. The general accepted policy in Southern Ontario is to provide, if possible, protection against the regional flood as defined in Chapter 3, "Hydrology". This protection may be reduced if loss of human life and extensive damage to property and services are considered extremely unlikely.

4. Reservoirs

(a) *Multi-Purpose Considerations*

The sites for the proposed reservoirs have been selected for multi-purpose use with the following functions considered:

(1) Flood protection for the Dresden and Wallaceburg area
(2) Water supply for municipalities, mainly Alvinston, Dresden and Brigden
(3) Recreational benefits from a lake associated with conservation areas
(4) Increased summer flow for pollution abatement and stream beautification.

The proposed sites and alternatives are briefly described in the following sections. The word "site" refers to the reservoir as a whole and "damline" to the location of the dam.

(1) *Alvinston Dam and Reservoir, East Branch*

The recommended site will develop a total storage of 49,900 acre feet at a

water level of 700 feet. This is equivalent to 3.1 inches of runoff from the watershed. This site could therefore contain the estimated runoff from a "Hurricance" type storm centred over the entire Sydenham Valley. The estimated cost of the dam and reservoir is $3,691,000.

(2) *Petrolia Dam and Reservoir, Bear Creek*

The purposes of the Petrolia Reservoir are flood control, recreation and low flow improvement. It could be used for water supply for Petrolia and Brigden. The dam proposed consists of a conduit spillway and a rolled earth fill embankment. It is estimated that it will provide a total storage of 28,500 acre feet and cost $1,356,000.

(3) *Brigden Dam and Reservoir, Bear Creek*

The purposes of the Brigden Reservoir are flood control, water supply for Brigden, low flow augmentation and recreation. It is estimated that this site will provide a total storage of 26,000 acre feet and cost $1,356,000.

(4) *Wilkesport Dam and Reservoir, Black Creek*

The purposes of the Wilkesport Reservoir are flood control and recreation. The increase in summer flow when discharged into the North Branch at Wilkesport will hardly be noticeable.

The dam will consist of a conduit spillway and a rolled earth fill embankment. An emergency spillway will be located north of the main dam. The reservoir will provide a total storage of 13,000 acre feet and will cost $1,100,000.

TABLE 5

ESTIMATED FLOWS FOR PROPOSED DAMS

Date	Drainage Area Sq.M.	Rain —Ins.	Runoff —Ins.	Peak Flow c.f.s.	Rain Ins.	Runoff Ins.	Peak Flow c.f.s.
Alvinston	275	6.8	5.4	33,000	12.0	9.6	52,400
Petrolia	—	7.8	6.2	15,800	14.5	10.5	28,000
Brigden	214	7.2	5.5	23,000	12.7	8.7	37,200
Wilkesport	134	6.3	4.8	14,200	11.7	7.8	25,000

For a preliminary design to estimate spillway costs the probable maximum was used for the Alvinston Dam and the regional flow for the others.

5. Flood Protection Provided by Reservoirs

The critical area to be protected is Wallaceburg, located at the confluence of the two main branches. Due to the shape and orientation of the two basins it is believed that the maximum rain floods would be generated from a storm centred over both North and East Branches. Table 6 outlines rainfall and runoff for different storms.

TABLE 6

STORM RAINFALL AND RUNOFF

Storm	Period of Hours	Rainfall in Inches	Runoff in Inches	
			60%	80%
50 Year	6	3.5	2.1	2.8
50 Year	24	4.3	2.56	2.05
100 Year	6	4.2	2.52	3.36
Hazel	12	5.6	3.36	4.48

Similarly, rain and snowmelt floods would develop simultaneously on both Branches. Based on present hydrologic data, reservoirs to control 60 per cent of the regional flood equivalent to "Hazel" or 80 per cent of "100-year flood" could be used as an acceptable standard for the degree of flood control to be provided. Therefore, reservoirs which provided 3.36 inches of flood storage can effectively control the project design flood. Table 7 outlines the area controlled by the recommended reservoirs.

TABLE 7

CONTROL PROVIDED BY RESERVOIRS

Reservoir	Drainage Controlled by Reservoir	Per Cent D.A.* Controlled	Storage Inches	Runoff to be Controlled (In.)	Excess Runoff Inches
East Branch					
Alvinston	275	47	3.1	3.36	0.25
Total	275	47			
North Branch					
Petrolia	92	20	4.63	3.36	Nil
Brigden	101	22	3.36	3.36	Nil
Wilkesport	134	29	1.71	3.36	1.65
Total	327	71			

*Per cent of drainage area controlled, based on 460.4 square miles for the North Branch and 579.7 for the East Branch.

6. Costs of Reservoirs

The cost of flood control measures may seem staggering to an Authority with a small population. However, the cost of the works must be viewed in the light of possible damages and loss of life.

It has been estimated from aerial photographs that 1,175 homes and 263

commercial and industrial establishments in Wallaceburg and Dresden will be flooded when the next "25-year" flood occurs. Based on $500 per home, and $2,000 per commercial establishment, the flood damage for these items alone in one flood will be over a million dollars.

7. Diversions

(a) *Wilkesport Diversion*

For many years residents of the Wilkesport and Wallaceburg area have suggested a diversion from Bear Creek to the St. Clair River to help solve Wallaceburg's flood problem. Basically, the diversion would involve an excavated channel from the 16 Sideroad to Clay Creek and a dam located on Bear Creek upstream of its confluence with Black Creek.

For preliminary estimates a flow of 4,000 c.f.s. was selected for the channel. This would require a channel with a minimum cross-section of 784 square feet and a length of 25,300 feet. Four new road bridges and a new railway bridge would be required.

The dam required to raise the water level above the elevation of the channel inlet could be a rolled earth fill dam with a conduit spillway sized to pass flows in excess of the discharge capacity of the diversion channel. The spillway would also be required to control the water level in the reservoir.

The cost of the diversion is estimated at $1,108,000 and the dam at $1,381,000 giving a total of $2,986,000. Dams at Petrolia and Brigden can effectively control the upper watershed (7 per cent of the area above the diversion) at a cost of $2,687,000. These dams are also multi-purpose.

The diversion at Wilkesport is therefore a less feasible measure of flood control, and is not recommended.

(b) *Dresden Dam and Diversion*

Since the Alvinston Reservoir controls only 47 per cent of the area of the East Branch, flow from the uncontrolled area could flood Dresden and Wallaceburg. Sufficient hydrologic data are not available at this time to estimate accurately the flows from the flat topography of the East Branch below the Alvinston Reservoir. Although it is envisaged that high runoff will not be likely to develop, the large drainage area could still generate large flows.

Additional protection for Dresden could be provided by flood gates across the river at the east side of town. Flows down the river could be limited to the channel capacity of 10,000 c.f.s. The balance of the flow could be diverted down a channel constructed along a natural depression located along the north side of the town. The cost of a dam and diversion each designed to pass 10,000 c.f.s. is $1,839,000.

The degree of flood protection that can be provided by this method is limited by backwater in the East Branch.

Because of the limited hydrologic data available and the complications involved in deciding on the feasibility of the diversion at this time, this project is recommended for additional study at a future date after the reservoirs have been constructed.

(c) *Wallaceburg Diversions*

Because of the extremely low channel capacity of the river at Wallaceburg, the town could still be flooded by the uncontrolled drainage areas below the proposed dams, although the frequency of flooding, and the high flood peaks will be greatly reduced by the reservoirs. Again sufficient hydrologic data are not available to make an accurate appraisal of the situation.

The diversion would be located in an area east of Wallaceburg and flow south from the East Branch to Con. XVI Chatham Township, and south-west to the Chenal Ecarté. Part of the flow from the North Branch might be diverted east of the town to the main diversion. Flood gates would be required in the North and East Branches to limit the flow through town.

This project will require an extensive engineering study, and is recommended for future study, after the proposed reservoirs have been completed.

8. Diking

No additional diking for flood control has been recommended at this time.

Diking in Wallaceburg would involve the construction of a steel pile and earth fill flood wall. The river channel through Wallaceburg is 25 feet deep on the average. The cost of steel sheet piling for the wall and the necessary property, most of which is commercial, would be prohibitive.

A possible approach is to carry the work out over many years. In many sections the existing revetments are in poor condition and need repair. As these sections are repaired they could be constructed to a top elevation of 585 feet as a floodwall. This recommendation should be coupled with the proposal that Wallaceburg prepare a master plan for water front development.

9. Zoning and Flood Plain Acquisition

An efficient and economical method of flood control is the restricted use of flood plains. The flood is allowed to spill across the flood plain, but because use of the flood plain is limited to park and open space and agriculture, there is far less damage than in built up areas.

Zoning requires municipal control of the development of the flood plains. In many cases, in order to restrict or restore flood plains to uses designated above, it is necessary to acquire them.

When developing zoning or an acquisition program there are three important definitions to be considered.

(a) *Flood Plain Lands*

The area adjoining the river or stream which has been or may be hereafter covered by flood waters.

(b) *Floodway*

The channel of a river or stream, and those portions of the flood plains and adjoining channels which are reasonably required to carry and discharge the flood water or flood flow of any river or stream.

(c) *Conservation Lands*

As applied to the lower sections of the main valley systems, this term includes all the land between the crests of the valley slopes.

In the flood plain acquisition programs it is preferable to acquire to the limit of conservation lands. The Authority then controls the valley slopes which are extremely important for the development of parks and open space.

The Sydenham Valley Conservation Authority already has initiated a program for the acquisition of flood plains in Strathroy. It is recommended that this program be continued.

As noted in the chapter on water problems, the commercial and some residential sections of Strathroy are subject to flooding. As a result, flood plain management here may have to include improvements to the channel and it is recommended that an engineering study be carried out to evaluate this need.

It is recommended that a program, either by the Authority or the town, be initiated to maintain flood plain and conservation lands in the Town of Petrolia as park land or open space.

Recommendations in respect to flood plains in Wallaceburg and Dresden have been given in Chapter 6.

CHAPTER 8

WATERSHED PLANNING AND RIVER MANAGEMENT

1. Watershed Planning

This term can be described as planning the management of resources for our present and future needs. Watershed planning must be based on the renewable and non-renewable resources in the basin.

Watershed management must be dynamic and flexible. It must be dynamic to keep pace with population and industrial growth. It must be flexible so that it can incorporate the new ideas of science and the new objectives of local and regional planning.

2. Resources

(a) *Non-Renewable*

Non-renewable resources are materials such as oil and iron ore which once removed, are not replaced by nature in any reasonable time according to man's life scale. These resources are important because they support mining and the heavy industries such as steel mills.

(b) *Renewable*

Renewable resources are those which are regenerated naturally and include water, soil, forest, fish and wildlife. This section is primarily concerned with water, especially the control of excess runoff to prevent floods and conserve water for periods of low flow.

There is an important time factor in the regeneration of renewable resources. Water is replaced continually by rain and snow although the quantity can vary considerably from time to time. As an example, the present low water level of the Great Lakes has been caused by low precipitation over the past ten years.

A reservoir can be created by a dam constructed in one to two years, but it takes 10 years before a forest would be of significant value in the water regime.

It is therefore imperative that the factors which will affect the future demand on renewable resources be carefully reviewed and a sound program established now.

3. Planning

Planning can be defined as: "the orderly consideration of a project from the original statement of purpose through the evaluation of the alternatives to the final decision on a course of action". It includes all of the reconnaissance and preliminary work associated with the design of a project. The final engineering is not included, as it is carried out according to criteria established during the planning stage.

When planning is undertaken, the subject area must be carefully defined. With watershed planning, the limits of the planning area are defined by the drainage area.

The planning for an entire river basin may involve complex and costly studies depending upon the nature of the problems. However, experience has proven that the expense of such studies is well warranted, since they may save the cost of constructing unwise projects. It is important to note that the planning phase is just as important in the case of small river basins or projects as in large ones, since the difficulties in arriving at the correct decision may be equally great.

The planning for water resources development should be integrated with the overall planning for the watershed. Because each water-development project or river basin is unique in its physical and economic setting, it is impossible to describe a simple process which will inevitably lead to the best decision. Subsequent changes in technology, economic development, and public attitude will make it necessary to revise the plan periodically but the long range objective must be maintained.

4. Data Needed for Planning

Accurate and extensive data are required for planning for water resources development. Long-term records on rainfall, streamflow and ground-water levels are the backbone of the hydrologic data. Other data on flooding, municipal and irrigation water requirements are also needed.

5. Projections for Planning

To estimate future requirements, the data on present needs must be projected. This projection should be more than a simple extrapolation of past growth curves, because economic, technological and social developments may cause significant changes in the trends.

Population forecasts of significance to the Sydenham River area, Table 8, were obtained from the Economics Branch, Department of Economics and Development. The Economics Branch prepares population forecasts for towns greater than 10,000 and all countries.

TABLE 8

POPULATION FORECASTS

Counties	1961	1966	1986
Kent County	89,400	93,600	105,000
Lambton County	102,000	118,800	238,000
Towns			
Wallaceburg	7,800	10,500	12,000

It should be noted that Lambton County is expected to more than double its 1961 population by 1986.

6. Setting of Objectives

After the basic data, projections and problems have been reviewed, the Authority must establish objectives for its programs.

There are four principal steps in the development of water resources and flood control:

1. Evaluating the problem
2. Identifying the objectives of the project
3. Translating the objectives into project design criteria
4. Evaluating the feasibility of the project on a benefit and cost basis

Following these steps will help the Authority arrive at a workable solution to problems in a business-like manner.

In following the four basic steps, the Authority should try to see its problems against the wide perspective of watershed development, and when possible, integrate its projects with other schemes for area development.

7. River Management

Rivers have been of great importance to man through the ages. They have been a source of supply for water and power and a road by which to explore and develop new lands.

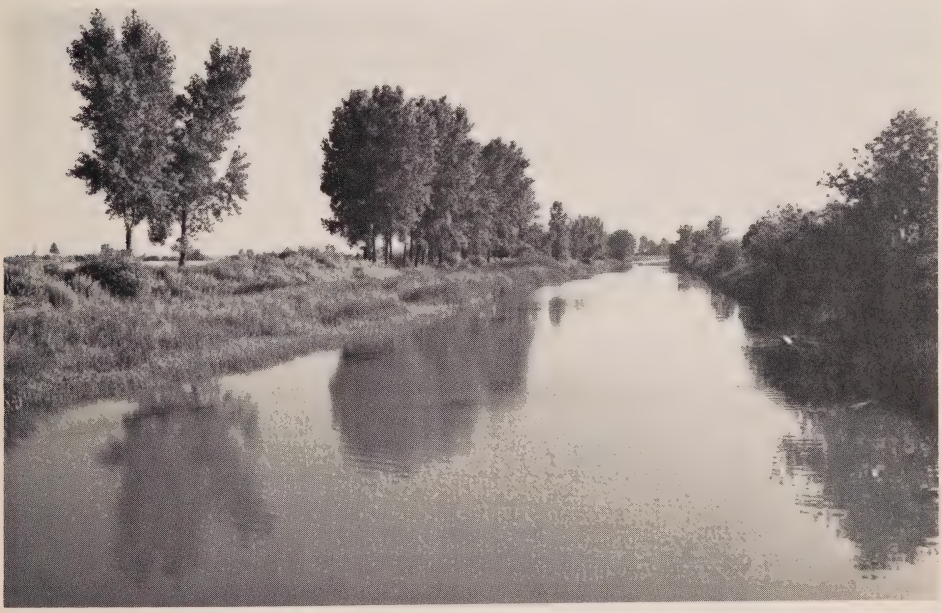
Today, however, through lack of knowledge and foresight, rivers and streams have become stagnant and polluted. The water in most cases is unfit to drink and the stream itself is unsightly.

A complete treatment of this complex subject is beyond the scope of this report, but it is hoped that this review will be sufficient to establish the importance of river management and its relationship to watershed planning and development.

8. Physical Nature of Rivers

The physical features of the stream can provide much information about the hydrological nature of the basin.

Such features as the degree of branching of the stream, the length of streams per unit area drained and the stream profile or change in elevation may all be of importance.



The Sydenham River, looking downstream from Highway 40 bridge, three miles west of Wallaceburg.

The cross-section of the river can tell a great deal about its life history. A geologically young river is actively eroding its channel and cutting it deeper. Young streams are normally clear and swift. They are capable of transporting all the sediment load delivered by their tributaries. Consequently the valleys of young streams are steep-sided and the streams occupy all of the narrow valley floor.

Mature streams have reduced slopes and water velocities will hardly carry the debris delivered by the tributaries. They are no longer able to erode their channels deeper, and lateral erosion begins, resulting in the development of flood plains. Mature streams have valleys with gentle side slopes and a regular channel profile without rapids or waterfalls.

All the larger streams in the Sydenham Valley, East Branch, Bear Creek and Black Creek, are mature streams.

Streams are commonly classed according to three types on the basis of constancy of flow:

Perennial or continuous streams contain water at all times, except during extreme droughts

Intermittent streams carry water most of the time but cease to flow occasionally because evaporation and seepage into their bed and banks exceeds the available streamflow

Ephemeral streams carry surface water only briefly from rains or periods of snowmelt.

9. Considerations in River Management

The list of considerations below identify the main points which must be considered in sound river management. Additional considerations could be added to the list, but it contains the ones of immediate concern to the Authority.

1. Flooding
2. Low flows
3. Pollution
4. Water quality
5. Stream beautification
6. Stream bank erosion
7. Flood plains
8. Fill violations
9. Recreation potential
10. Navigation
11. Effects of construction on river i.e. bridges, docks, etc.

10. Legal Aspects

The following Federal and Provincial Acts control the use of lakes and rivers in Ontario.

(a) *Navigable Waters Protection Act* is administered by the Department of Public Works, Ottawa.

The Act is intended to ensure the public right of navigation only on a stream. If the stream is declared navigable the Federal Goverment assumes the responsibility for dredging and navigation, but not for flooding or erosion control.

The Sydenham River at Wallaceburg is navigable for lake freighters and is much used for recreational boating.

The Sydenham River is navigable up to Wallaceburg and considered navigable up to Dresden on the East Branch and for an undefined distance up the North Branch.

(b) *The Lakes and Rivers Improvement Act* is administered by the Ontario Department of Lands and Forests.

The purpose of this Act, which consolidated previous legislation in 1927, is to control the construction of dams and other works on lakes and rivers and to provide for safe and orderly use of such waters for the purposes of transporting timber. It also includes provisions for regulating usage of these waters to avoid discrimination against persons having other interests in them and for the regulation of lake levels in the public interest. An amendment to this Act in 1962 stipulates that the location of all damsites in rivers under the jurisdiction of the earlier Act must receive approval by the Minister. The construction plans and specifications for the dam must also be submitted for approval.

(c) *The Water Powers Regulation Act* is administered by the Ontario Department of Lands and Forests.

This Act authorizes the Department of Lands and Forests to grant rights for use of water sources under lease agreements and requires that every holder of such rights use the water that is put at his disposal in an economic and efficient manner.

(d) *The Beds of Navigable Waters Act* is administered by the Ontario Department of Lands and Forests.

This Act provides that beds of navigable waters are vested in the Crown unless expressly granted.

(e) *The Conservation Authorities Act* is administered by the Ontario Department of Energy and Resources Management.

This Act was passed in 1946 for the purpose of co-ordinating local conservation efforts on a watershed basis and of providing means whereby approved conservation projects could receive provincial assistance.

Conservation Authorities established under this Act have the power to construct dams and other works for the control and development of water.

(f) *Ontario Water Resources Commission Act*

This Act, passed in 1956, established the Commission to control and regulate the use of water for public use. The Commission's activities have been directed towards water supply and pollution control.

There are additional Acts which may in some way affect river management, but the ones listed are the most important.

11. Authority Objectives

In river management, the Authorities in general have adopted the objectives of flood control, conservation of water for low flow improvement and streambank erosion control. They are also extremely interested in water quality and pollution.

CHAPTER 9

WATER SUPPLY

1. General

Investigations have indicated serious water supply problems on the watershed. There are municipal problems at Alvinston, Dresden and Brigden and agricultural problems throughout the basin. Multi-purpose reservoirs could be used to help remedy these problems.

It is important that all phases of water control and use be included in preparing a master plan for the basin. It is therefore important that the Authority gain the co-operation of the local municipalities and government agencies.

The absence of sewage treatment plants on the streams constitutes a serious pollution threat to the proposed reservoirs. Unless plants of adequate capacity are constructed, the reservoirs could become contaminated in a short time.

It is recommended that the Authority request municipalities to provide adequate sewage treatment plants before reservoirs downstream are completed.

Ground water is used extensively for both municipal and agricultural water supply and should be carefully considered in watershed planning. Because of its importance a chapter on ground water has been included to acquaint the Authority members with the ground-water processes. (See page 99).

2. Existing Water Supply and Sewage Treatment Plants

Strathroy — The town obtains its water from sand aquifers near the river. There is an abundant supply and the water is of high quality. The town has a sewage lagoon.

Alvinston — The village residents obtain water for domestic consumption from dug and drilled wells. The village has a distribution system for fire protection only using water pumped from the East Branch.

Falling ground-water levels in the area have caused many wells to fail. The villagers are now faced with the problem of deepening wells (if adequate ground water exists), or taking water from the river.

The village has no sewage treatment plant.

Newbury — Residents obtain water from drilled wells, which for the most part are 50 to 140 feet deep. There is no shortage of water at any time of the year. Sewage is disposed of through septic tanks. A storm sewer carries water from the streets to Haggerty Creek.

Bothwell — Water is obtained by dug wells ten to twelve feet deep. The aquifer contains an abundant supply so that there is no shortage. The town has a deep well and an 80,000 gallon open storage reservoir for fire fighting. Sewage is disposed of through septic tanks. Recent outbreaks of hepatitis have caused concern, and a sewage treatment plant has been recommended by the Ontario Water Resources Commission.

Florence — The village obtains its water from wells and has no sewage treatment plant.

Dresden — Dresden is concerned about the falling ground-water levels in the area because it depends largely on drilled wells for supply. Ground water recharged with river water has not proved successful.

During the summers of 1963 and 1964 Dresden experienced problems with blockage of the intake to its treatment plant. This was aggravated by the low water in the East Branch.

The Canadian Canneries require large volumes of water for operation during the canning season (from August to October approximately). The company hopes to length its period of operation, which would increase the yearly consumption of water.

Dresden, which at present has no sewage treatment plant, has retained consulting engineers to prepare a preliminary study. Outlets from septic tanks in many cases enter the storm sewers where the effluent is carried to the river.

The local Health Board is trying to correct this problem by requiring that all new septic tank installations be provided with weeping tiles.

Wallaceburg — Wallaceburg has a very good source of water supply at the Chenal Ecarté. The water is pumped to a reservoir in Wallaceburg.

Wallaceburg now has a sewage treatment plant under construction.

Petrolia — Petrolia obtains its water from Lake Huron by pipeline. The pipeline is 12½ miles long, running from the pumping station at Bright's Grove to Petrolia. It is understood that the system is working satisfactorily.

In addition to a 750,000 gallon surge tank in the Township of Plympton, a new 500,000 stand pipe has been added at the same location and a take-off provided for a 10-inch diameter supply line to Wyoming and Watford.

Petrolia is constructing a sewage lagoon under the joint supervision of their consulting engineers and the Ontario Water Resources Commission.

Wyoming and Watford — Are supplied from the Petrolia pipeline. Since they are not located on the river, lack of sewage treatment does not constitute a serious pollution threat to the river.

Brigden — Brigden obtains its water from drilled wells located at Kimball. There is a pumping unit in Brigden and a distribution system. There is no treatment of the water.

The wells have limited capacity and Brigden is constantly plagued with a shortage of water. They have been investigating the possibility of a pipeline from Courtright.

Brigden has no sewage treatment facilities. Sewage is dumped into Bear Creek.

Oil Springs and Wilkesport — Obtain their water from dug wells and in many cases, water has to be brought in by truck.

3. Use of Reservoirs for Water Supply

Reservoirs can be an excellent source of water supply. This water would be provided as conservation storage. The maintenance of conservation storage must be considered in the design and operation of the dam and reservoirs.

No attempt has been made to evaluate the feasibility of taking water from any of the proposed reservoirs as compared to the alternatives of pipelines or extending the well system. Feasibility studies would be required to compare capital costs of construction, operating and maintenance. The type of treatment required to purify the reservoir water would have an important bearing on the cost of water to the consumer.

Since the municipalities in the Sydenham Valley are small, the volume of water required to supply them is not great. Estimates were made of the water supply required during the critical summer period for all the inland towns and villages with a population of 500 or more.

The predicted 1986 population was used, with a per capita consumption of 150 gallons per day. The estimate was based on a summer period of 112 days from June 1 to September 20 when streamflow is low. It was assumed that during the balance of the year, the streamflow would be adequate.

TABLE 9

URBAN WATER SUPPLY REQUIREMENTS

Municipality	Estimated 1986 Population	Gallons per day	C.F.S.	Water Required	
				Acre-Feet per day	Acre-Feet for 112 days
Strathroy	8,000	1,200,000	2.20	4.3	482
Alvinston	930	140,000	0.26	0.5	36
Bothwell	1,200	180,000	0.33	0.7	73
Florence	500	75,000	0.14	0.3	31
Dresden	3,300	495,000	0.92	1.8	206
Watford	1,860	280,000	0.52	1.0	116
Wyoming	1,360	202,000	0.37	0.7	83
Petrolia	5,370	750,000	1.39	2.8	311
Brigden	715	10,700	.20	0.4	45
Oil Springs	715	10,700	.20	0.4	45
Total	23,950	3,343,400	6.53	12.9	1,428

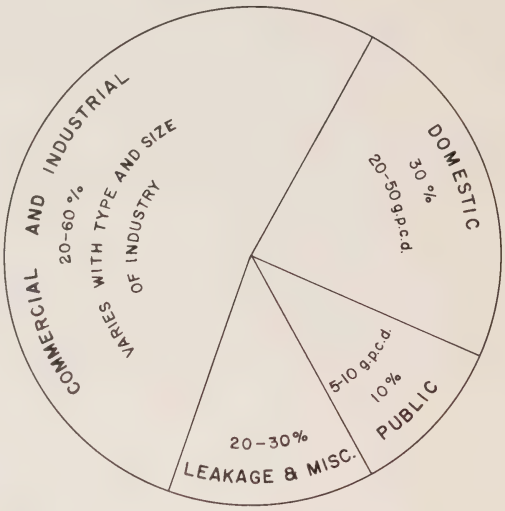
Low flow studies for the East Branch at Alvinston as outlined in Chapter 3 indicate that the natural streamflow would be sufficient on the East Branch.

4. Agricultural Water Supply

(a) *General*

Farmers in the Sydenham Valley frequently experience water shortage. During the years of 1963 and 1964 this problem became severe and received a great deal of publicity. As a result the government undertook to remedy the situation by setting up new programs for the construction of small reservoirs and farm ponds.

CONSUMPTIVE USES OF WATER



NOTES:

(1.) g.p.c.d. — GALLONS PER CAPITA PER DAY
(2.) RATES VARY WITH MUNICIPALITY, g.p.c.d. AND PERCENT ARE APPROXIMATE ONLY
(3.) AGRICULTURAL USES ARE NOT INCLUDED

TYPICAL MASS CURVE

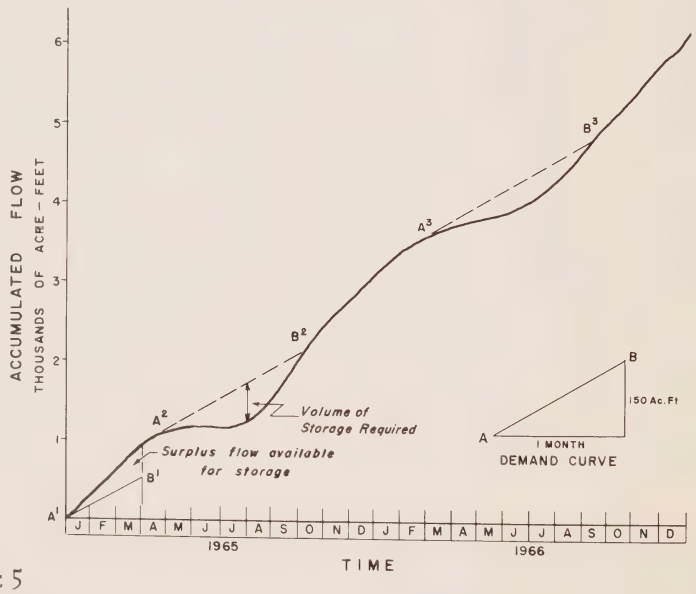


FIGURE 5

CONSERVATION AUTHORITIES BRANCH, DEP'T. E.&R.M., Wm.M. 1965.

Farm ponds can be an excellent source of water for agricultural, domestic and recreation purposes.

Water problems are not new to the Sydenham Valley farmer. Periodically, he has faced this problem by digging deeper ponds and cleaning out the old ones, buying water, and moving livestock herds to areas where water is available.

Even with the new government programs this problem will again strike many farmers. It is important that farmers with limited water start planning immediately to increase their supply.

(b) *Sources of Agricultural Water Supply*

The main sources of water supply are:

1. Reservoirs
2. Wells
3. Farm ponds

Reservoirs provide an extremely good supply of water. However, the number of farms that can use a reservoir is limited to those located around a reservoir's perimeter unless a pumping and distribution system is provided. Such a system can involve considerable capital expenditure. Unless a large number of farmers carry the cost, farm ponds or wells will be more economical.

Wells are preferred if aquifers with an adequate supply of good quality water can be found. This water is clear and cold and is very attractive both for livestock and domestic consumption.

Depending on the source of water, farm ponds may be dugout ponds, spring-fed or runoff ponds, by-pass ponds or impoundments on permanent streams. A booklet showing different types of ponds may be obtained from the Ontario Department of Agriculture and Food. Application for engineering assistance or provincial subsidy should be made through the local Agricultural Representative.

(c) *Capacity of Agricultural Water Supply Systems*

The capacity of the system will depend upon the size of the farm and type of enterprise. Agricultural water requirement is made up of:

1. Household water supply
2. Livestock water supply
3. Fire protection for farm buildings
4. Irrigation and spray water supply

If the supply is from a farm pond, considerations of fish production, recreation and wildlife habitat may also be included.

Table 10 gives the storage requirements for various farm uses.

TABLE 10

FARM WATER REQUIREMENTS

Item	Unit	Gallons Per Month	Total in Gallons
Livestock			
(a) Cattle, drinking only	per head	500	
drinking plus sanitation	" "	1,500	
(b) Hogs	" "	100	
(c) Sheep	" "	100	
(d) Chickens	per 100	300	
(e) Turkeys	" "	500	
Household	per person	1,500	
Fire Protection			200,000
Irrigation	per acre		200,000
Warm water fish production			3,300,000 minimum

(d) *Irrigation Requirements*

Future irrigation water requirements should be discussed with the local County Agricultural Representatives.

At present there is only limited irrigation in Chatham and Camden Townships. It is believed that there will not be a marked increase in irrigation in the watershed.

GROUND WATER

1. General

Ground water is an extremely important renewable resource. It consists of all water existing in the voids and openings of soil and rocks beneath the earth's surface.

The amount and availability of ground water depends on the porosity and permeability of the geological formations. Porosity is the ratio of the volume of voids to the total volume of a given unit of soil or rock. Permeability is the capacity of the soil or rock to allow water to move through the voids.

All soil and rock has some degree of porosity and permeability. Most rock, however, has so few inter-connected voids that for most purposes it may be considered impermeable.

A fine-grained soil such as clay may have a high porosity and yet may be almost impermeable due to the small size of the openings between particles. A coarse-grained soil such as sand or gravel may have a low porosity and a high permeability.

There are many soil types and combinations having characteristics between these two extremes that will give varying degrees of porosity and permeability. In considering ground water, both the surface soils and geological profile are significant.

The porosity and permeability of a geological formation are important factors in the determining of the properties of a ground-water aquifer. A permeable formation, if saturated with water, provides a high yielding aquifer.

Ground water may be divided into two zones: the upper or "zone of aeration" and the lower or "zone of saturation".

2. The Zone of Aeration

The zone of aeration comprises the soil between the ground surface and the zone of saturation. Water is held in the zone of aeration against the force of gravity by the capillary action. This zone of aeration receives surface water by infiltration, and holds a certain amount which is depleted by evaporation and transpiration. It is the collecting zone for practically all the water in the zone of saturation. The zone of aeration contains all the water available for plant growth except where the root system penetrates to the zone of saturation.

There is a limit to the amount of water which can be held in the zone of aeration. Only when this limit is exceeded can water gravitate to the zone of saturation. Water held in the zone of aeration cannot be economically extracted.

3. The Zone of Saturation

The zone of saturation is that portion of the soil in which all voids are filled with water. The upper surface of the zone of saturation is called the "water table". All water below the water table, acting under the force of gravity, moves within the soil as a result of differences in elevation.

4. Ground-Water Basin

Ground water exists in basins and reservoirs similar to surface water, but the boundaries are not as easily defined. In general, the top surface or groundwater

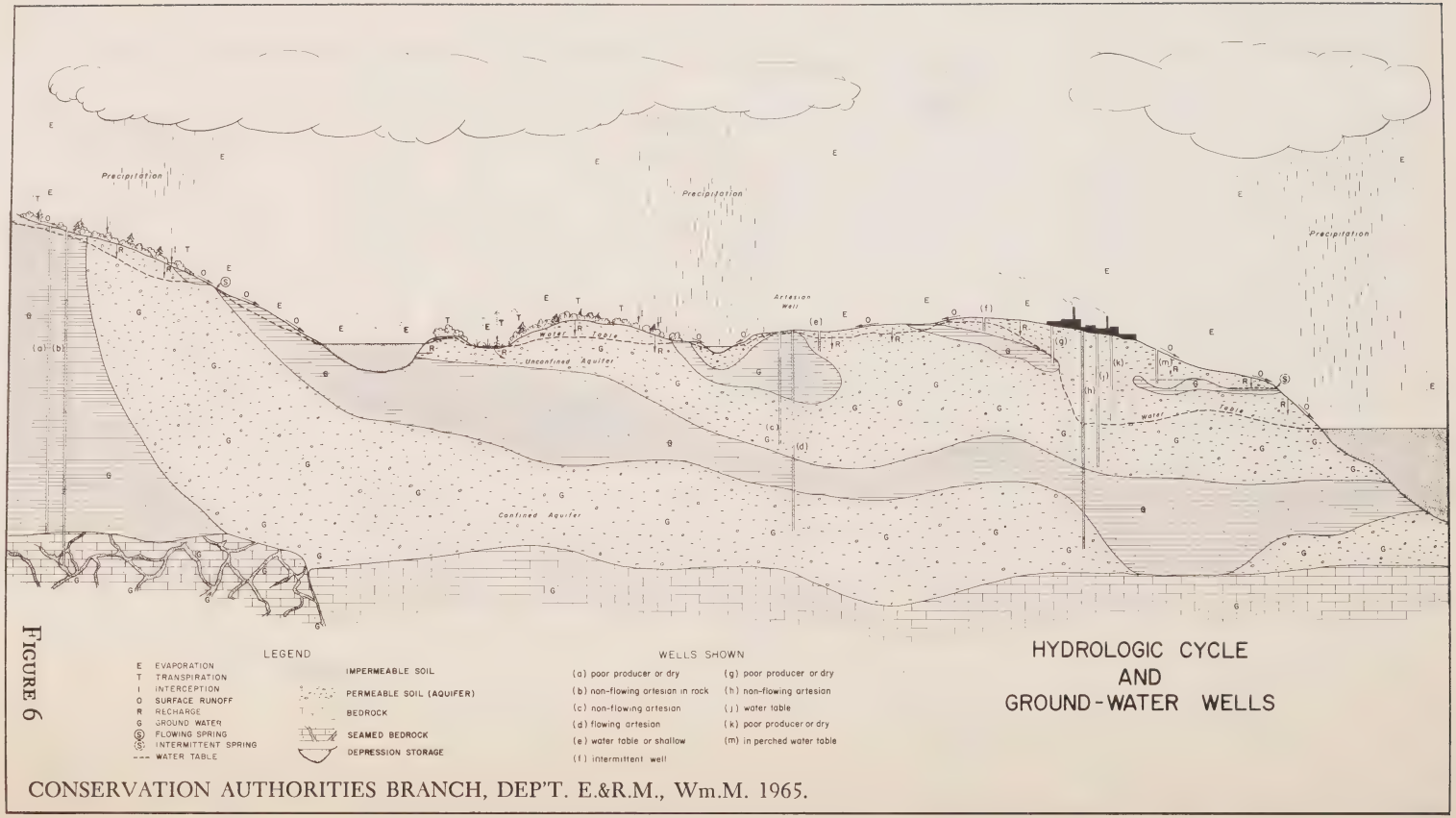


FIGURE 6

CONSERVATION AUTHORITIES BRANCH, DEP'T. E.&R.M., Wm.M. 1965.

table conforms to the surface topography but with less prominent peaks and valleys.

5. Aquifer

This term is usually applied to a geological formation of relatively high permeability which yields or conveys water. The water it contains can be easily withdrawn.

6. Well Construction

A well is a hole or shaft excavated, usually vertically, in the soil or rock for the purpose of extracting ground water.

A well may be dug, bored, driven, jetted or drilled. The particular method used for excavating a well is dependent on the amount of water which is required from the well, the type of material through which the well is to be excavated and the depth to the aquifer. The decision as to the type of well best suited to any given location should be based on the opinion of a competent well driller.

After excavation, the well is usually completed by placing a screen and well-graded sand and gravel around the bottom of the well casing. This is one of the most important aspects of well drilling. It serves as a filter to prevent the fine particles of the surrounding material from being carried into the well by the water.

7. Pumping

Under pumping, the water surface or the pressure in the well is lowered. This drawdown establishes a hydraulic gradient between the well and the aquifer, so that water will flow to the well. The drawdown creates a cone of depression around the well. It is not uncommon for this cone of depression to extend and affect the water level in nearby wells.

The quantity of water and the rate at which it can be withdrawn from a well is best determined by a pumping test performed by a competent well driller. The pumping test will determine the maximum pumping which will not be detrimental to the well. It is obvious that the withdrawing of water from an aquifer in an amount in excess of the recharge will eventually result in depletion of the water supply. This depletion will be noticed by a gradual decrease in the elevation of the water table or the pressure in artesian wells.

The wise and efficient use of water resources requires that excess water be stored and that it be used wisely during periods of deficiency. A ground-water reservoir, like a surface reservoir, may be drawn down during the dry periods making room in the reservoir to store the surplus during periods of excess. Therefore, we should not become alarmed at seasonal or climatic fluctuation in the ground-water supply, provided the levels return to normal after periods of excess. However, where evidence indicates that ground-water levels are being permanently lowered, the pumping rate should be reduced, and additional or alternate sources of supply investigated.

8. Ground Water in the Sydenham Valley

The ground water is directly related to the geological conditions. As noted in Chapter 1, the bedrock throughout the watershed is of the Kettle Point Forma-

tion. It is overlain by shale and sandstone of varying thickness. The depth to shale varies from 10 to over 200 feet.

The main constituent of the overburden is a clay which varies in colour from blue to grey. Some layers have been classified as hard. Interspersed throughout the overburden are deposits of sand and gravel. These are glacial deposits and act as aquifers if located below the water table. Their general location is along the main tributaries and at the mouth of the Sydenham River.

There is a very little water percolation through the clay or shale. Wells located in the shale receive water through fissures in the shale. They generally have a low pumping capacity and may be subject to sulphur contamination.

Logs of drilled wells for the Townships of Brooke, Dawn, Enniskillen, Sombra, Euphemia, Chatham Gore, Camden Gore, Moore, Metcalfe and Caradoc are published by the Ontario Water Resources Commission.* These townships cover most of the watershed. These records give the general geological and ground-water contions to be found in the area.

During the period 1953-56 wells were drilled at approximately 300 locations in the above noted townships. At some locations several wells were put down. Eighty locations gave nothing but dry holes. Thirty per cent of the productive locations yielded less than three gallons per minute.

The above figures are of limited accuracy. However, they do indicate that ground water is not plentiful in the Sydenham basin. Therefore the development of ground-water resources in the basin should be carefully controlled. It is recommended that the Authority co-operate with the Ontario Water Resources Commission on the development of ground water and request that the Commission establish observation wells at critical points.

*OWRC, Ground Water in Ontario 1953 and 1954, Bulletin No. 1
OWRC, Ground Water in Ontario 1955 and 1956, Bulletin No. 2

CHAPTER 11

EROSION CONTROL

1. General

Stream-bank erosion is a major problem in the Sydenham Valley. Works required to control erosion will be extensive and expensive.

A complete survey of the streams to classify the seriousness of erosion was not attempted. A survey of this nature would require considerable time and much of the report would be obsolete before remedial work were initiated. Secondly, nearly all the erosion occurs on private land. The Authority, therefore, will have to consider its position in relation to stream-bank erosion on private lands.

A few sites of severe erosion on the East Branch were selected as examples, and topographic surveys of the areas have been prepared and forwarded to the Authority.

Because of the widespread occurrence of this problem, it is recommended that the Authority restrict its assistance for erosion control on private lands to the provision of technical advice and the demonstration of suitable methods.

There are many types of works which can be used for erosion control. Many could and have been used successfully by interested individuals. The balance of this chapter is devoted to outlining erosion processes and remedial control measures.

2. Relationship Between the Soil and Erosion

The soil overlying the Sydenham Valley is of lacustrine and glacio-fluvial origin and consists mainly of clay and sand plains. Because of their fine texture many of these soils are highly susceptible to erosion by water.

The rate of erosion varies according to the type of material and the velocity of the water flowing over it. The lighter fine-grained soil particles are more easily moved than the coarser, heavier particles. The greater the velocity or energy of the flowing water, the greater its ability to carry away the soil particles. Doubling the slope of the land will increase velocity four times. Doubling the velocity will increase the abrasive power four times and the capacity to carry particles by as much as 32 times.

3. Types of Erosion

Erosion may be divided into three classes: sheet erosion, gully erosion and stream-bank erosion.

Sheet erosion is the result of raindrops and overland flow removing the surface soil. In some areas, this process takes place easily; thus miniature watercourses called rills appear. As the erosion process continues these rills are deepened and if not controlled eventually may become gullies.

Gully erosion occurs in what may be described as large rills or intermittent streams. As the gully slopes become steeper, the velocity of the flow increases and the rate of erosion is accelerated. Eventually the gully deepens to where it may intercept the ground water table, forming a stream. Up to this time the erosion occurred only for a short time after the spring breakup or heavy precipitation. In streams the erosion process now becomes continuous.

Stream erosion varies with the composition of stream banks and bed and the water velocity. Due to fluctuations in streamflow and different rates of erosion of the bank and bed, the stream picks up materials at one location and deposits them at points downstream. As this process continues the stream begins to meander through the valley bottom.

Once a meander is formed in the stream, the flow is diverted to the outside of the bend, increasing the rate of erosion on the outside of the bend and depositing material on the inside of the curve. This results in large bend curvatures and increased erosion.

Stream banks are also subject to erosion from wave action caused by both wind and boats. During the winter season stream banks are subject to erosion caused by the freezing and thawing cycles.

The suggested methods of controlling sheet and gully erosion by proper land use and forestry practices are contained in the Land and Forest sections of the Sydenham Valley Conservation Report (1963).

This report is concerned with stream-bank erosion which has progressed to the point where construction of mechanical remedial measures is required. The effective use of construction methods must, however, be supplemented by proper conservation practices upstream of the protective works.

In proposing remedial works there must be careful consideration of the allowable velocity to which the material can be subjected without eroding. Table 11 gives the allowable velocities for various materials.

Streambank erosion is a major problem in the Sydenham watershed.

TABLE 11

ALLOWABLE WATER VELOCITIES FOR VARIOUS MATERIALS

Material	Max. Allowable Vel. F.P.S.*
Very fine sandy soil or loose silt	0.5
Sandy loam, 15% clay	1.2
Sandy clay, 40% clay	2.0
Clay 65%	3.0
Stiff clay	6.0
Grass waterways	6.0
Small boulders	15.0

*Feet per second.

4. Methods of Stream-Bank Erosion Control

There are several methods which may be used:

(a) Bank Regrading
(b) Timber Piles and Sheeting
(c) Rubble Mound
(d) Placed Rip-rap
(e) Sacked Concrete (Sackrete)
(f) Gabions
(g) Steel Sheet Piling
(h) Timber Pile and Lagging
(i) Groynes
(j) Stream Realignment

(a) *Bank Regrading*

In areas where the bank slope is flat, relatively few erosion problems exist. Waves striking the shore run up the gentle slope. The wave dissipates its energy gradually through friction in running uphill, rather than by slapping against a steep face and dislodging material. After a period of high water, the pore pressures in the bank reduce the strength of the soil, but the weight of the flat bank is not sufficient to cause failure by sloughing or sliding. Therefore regrading banks to an appropriate slope for the material is an effective measure against erosion.

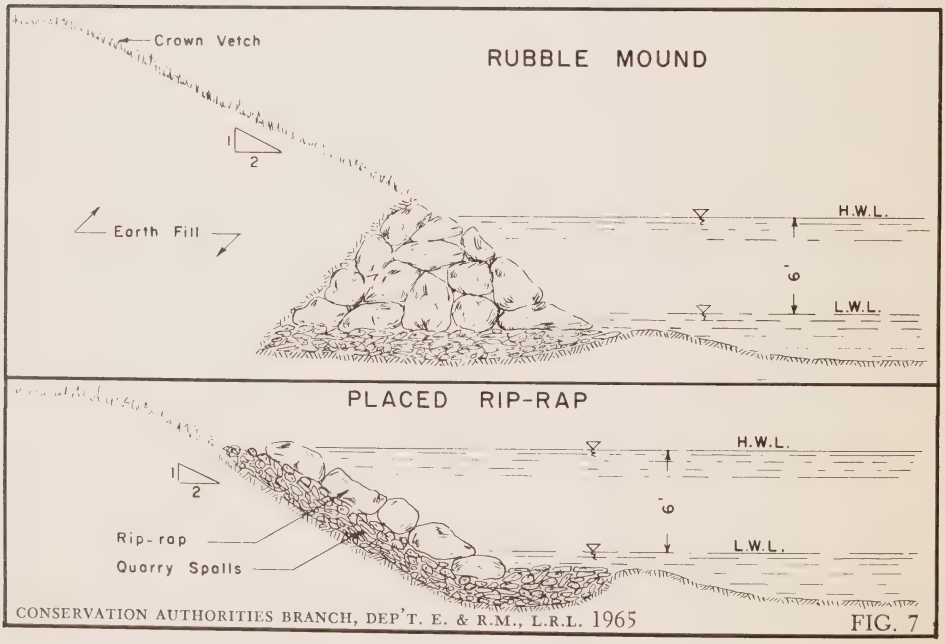
This method could be employed on many of the small tributaries and on the upper reaches of Bear Creek and the East Branch.

In locations where the erosion is not serious, willows and vegetative cover may be planted on the banks.

(b) *Timber Piles and Sheeting*

Timber piles and sheeting are the suggested control measure where the banks are almost vertical and there is little room for grading. Timber piles are driven parallel to the bank along the shoreline. A number of horizontal timber wales are placed along the piles to support close driven wooden sheeting to form a continuous wall. The area behind the sheeting is back-filled and graded. Retaining wires, attached to weights that are buried in the back-fill, are required for high walls.

Erosion control on the Sydenham River, at County Road in Metcalf Township, by means of ready-mix concrete in burlap sacks (Sackrete).



TYPICAL BANK PROTECTIVE MEASURES

The sloping bank above the timber may require a protective vegetative cover. All timber should be treated to retard decay and extend its life. Treated timbers have a life expectancy of 30 to 40 years.

This type of bank protection could be used in the Dresden and Wallaceburg areas where the banks are steep and high due to the erosion of dikes and high banks.

(c) *Rubble Mound*

The rubble mound type of protection is adaptable where the bank may be sloped and the bottom has sufficient strength to support the heavy stone. The mound is triangular in section and should extend beyond the high water level. Large quarried stone blocks are placed first, then larger crevices are chinked with smaller stone. A graded filter behind the stone is desirable to prevent the finer soil particles from being washed out. The earth should be sloped back from the top of the rubble rip-rap. In one installation at Prairie Siding on the Lower Thames River, the banks are in good condition after 15 years of service.

(d) *Placed Rip-rap*

Placed stone rip-rap is one of the most common types of bank protection. In this method, gravel is placed on the prepared bank over which is placed a layer of quarry spalls which form the bed for the large cover stones. The cover stone should be of sufficient size to resist disturbance by wave or ice action. The finer stone and gravel are necessary to prevent the removal of bank material. The principal advantages of this method are that it requires a minimum of engineering and is comparatively easy to construct.

(e) *Sacked Concrete (Sackrete)*

When there is room to grade the banks, the toe can be protected by sackrete. In this method, a small quantity of dry cement is mixed with gravel and placed in burlap sacks. Rows of sacks are placed along the toe from below water level up the bank against the slope, forming a revetment. Reinforcing bars may be driven through the bags to hold them together and in place until the dry concrete mixture becomes moistened and sets. If the sacks are wetted sufficiently some of the paste passes through the sack pore and cements the sack together. A continuous slab results. The surface burlap rots away.

An experimental section using sackrete was installed on the Lower Thames in 1962. To date it has worked satisfactorily.

The sackrete method is applicable where there is no ready source of quarried stone.

(f) *Gabions*

Gabions are wire mesh baskets which are filled with stone and securely wired together to form a flexible revetment or wall. There are several basket sizes and various combinations can be used to construct the type of protective wall required for the site. Chief advantages of gabions are minimum foundation preparation and easy construction. This method requires a considerable amount of hand labour, which increases the cost.

The use of gabions in the lower reaches of the Sydenham River is limited because the depth of water makes their placement extremely difficult.

(g) *Steel Sheet Piling*

This is the best method to give lasting results, but involves high initial capital costs. The nature and value of the property protected must be considered and, where long term protection is required, steel sheet piling should be used.

This is the type of wall required for many sections of the banks in the town of Wallaceburg where failure would result in damage to property and buildings.

This type of installation must be properly designed.

(h) *Timber Pile and Lagging*

Lagging differs from sheeting in that the planks are placed horizontally rather than vertically. This method is more economical, but is vulnerable to undermining unless protected along the toe.

(i) *Groynes*

A groyne is a structure located at an angle to the bank, rather than parallel to it. Its function is to deflect the high velocities to the centre of the stream. Groynes may be made of gabions, concrete, steel or timber piling or dumped rip-rap and rubble.

(j) *Stream Realignment*

In some cases it may be necessary to relocate a reach of a stream to cut out an oxbow or move the stream away from a high bank.

On large streams an engineering study should be carried out before the realignment is made.

5. Costs for Erosion Control

A brief summary of unit costs for the various protective measures is given in Table 12. The costs are based on only a few installations and are approximate only.

TABLE 12

UNIT COSTS FOR TYPICAL EROSION CONTROL MEASURES

Type	Approx. Cost per Linear Foot of Bank
Bank regrading	$ 10
Timber piles and sheeting	50
Rubble mound	30
Placed rip-rap	30
Sackrete	10
Gabion basket	30
Steel sheet piling	200
Timber pile and lagging	30

Cost varies according to bank height and depth of channel.

PART IV - RECREATION

CHAPTER 1

RECREATION RESOURCE PLANNING

In planning the development of outdoor recreation resources two basic approaches are possible. The first might be termed *inflow* which studies the people, activities and facilities within a given resource area. From such a study projections are derived as a basis for planning and developing further recreation resource areas. The second approach might be termed the *outflow* method. Here the concern is with people, their needs and patterns of social behaviour in their everyday settings; in the home, on the job, in informal groups.

Most basic research related to recreation resources has been done in inflow studies. However, a large body of scientific literature has been built upon study of the needs, interests and behaviour of people.

In addition to the study of people, planning must take cognizance of social and economic factors affecting the individual. Frequent reference is made in current literature to the impact of urban concentrations of population, improved standards of living, increases in leisure, mechanization and automation, changing family roles, increased mobility, and intensified land use demands. Only recently has any significant attempt been made to bring all these factors to bear on the problems of recreation resource planning.

It is recognized by all levels of government in Canada today that fostering and providing a rich program of leisure opportunities is a public responsibility. This is clearly attested in municipal, provincal and federal legslation. It is questionable, however, whether all such legislation has been based on scientific study.

Some goals in the field of recreation follow:

1. to provide equality of opportunity for all. This means provision of areas and facilities for all areas of a jurisdiction.
2. to provide for a wide range of individual choices in different types of activities.
3. to provide for the needs and interests of all age groups.
4. to provide the means to enable individuals and groups to develop their own activities.
5. to give the "users" a share in planning through commissions and local authorities.
6. to assure safe and healthful conditions.
7. to make provision for minority interests as well as majority demands.
8. to be sensitive to changing conditions and needs.

The Government of Ontario, in co-operation with local governments and regional authorities is moving toward these goals.

CHAPTER 2

EXISTING RECREATION RESOURCES

The Sydenham Valley is quite sparsely populated. There are no large urban areas — indeed, there are no cities throughout the area. There are five towns, of which Wallaceburg with a population of 8,000 is the largest. The total population of the Sydenham Conservation Authority is about 50,000 persons, the majority of whom live in rural regions.

The land is generally quite flat except in the upper reaches of the two main branches of the river, where there is some undulation and gorging of the river channels. Mixed farming is the general farm practice, but in Enniskillen Township there are oil and gas wells and a refinery.

The whole area gives the impression of general prosperity. Many old farm homes of 19th century vintage are scattered through the area. The Sydenham Valley gives a feeling of history — not bloody conflict and conquest, but rather families living on the land generation after generation.

The Sydenham Valley is to a large extent by-passed by the main stream of road travel in Ontario. Highway No. 22 from London to Sarnia crosses only the northern edge of the watershed while Highway No. 2 completely skirts the southern edge. Indeed, it seems that little effort has been made to attract people to this area. A great attraction of the area is the fact that it is to a large extent free of the hustle and bustle of most Ontario communities.

Population growth in the Sydenham is slow; it would appear that this will remain an essentially rural, agricultural area for many years. A small rate of growth is anticipated in the town of Wallaceburg, Dresden, Petrolia and Strathroy. The population of the area itself would not place an undue strain upon the proposed recreation developments.

This area is, however, within a one-hour drive for approximately 250,000 people living in the cities and districts of London and Sarnia. Roads throughout the area are good and there are many of them. All proposed sites are easily accessible. While recreation development can be readily justified on other bases, the fact is that developments in the Sydenham would probably contribute to the economic wealth of the local citizens.

Present Recreation Areas

Outside the towns and villages, the Sydenham Valley is completely devoid of recreation areas. Melwood Park, a privately-owned area of some 400 acres, is under development. It opened on a limited basis during the summer of 1961, serving for the most part families from London. It is located on the East Sydenham, eight miles south-west of Strathroy and will provide a swimming pool, rental cottages, fishing, and camping facilities. Further non-specified developments are planned for the future.

For much of their recreation, the resident of the Sydenham area must travel outside the watershed to the parks and beaches of Lakes St. Clair, Huron and Erie. While this involves some travel for the residents, it requires no expenditure for recreation on the part of the public authorities of the Sydenham Valley.

There is not, at present, a great demand for the services offered by public recreation facilities. This is possibly due, to some extent, to a lack of familiarity with such services.

What the Sydenham Valley does offer, and in abundance, is uncongested space. On an informal basis, fishing, hunting, walking and communing with nature have always been possible in the daily lives of the residents. Restrictions on mobility in rural areas develop slowly. In this area there is yet time to make adequate provision for public control of recreation areas. The time to act is now.

The Sydenham Valley offers uncongested space. This photograph, looking east from the bridge at Alvinston, shows picnic areas along the creek.

CHAPTER 3

PROPOSED CONSERVATION AREAS

Seven separate Conservation Areas are recommended for the Sydenham Watershed. All of these are suitable properties for recreation development and use. They were selected after an on-site study of the total area. Their development will contribute significantly to conservation in terms of water, forestry, history and land use. While sound conservaion practices are the basic criteria on which land selection is made, the recreation needs of people are the primary consideration in the developmental plans contained in this section of the report. These considerations are manifested in a concern for equitable distribution of recreation sites throughout the area, accessibility of the sites, and variety of potential uses as dictated by topography. More than 90 per cent of the population of the watershed is within 15 miles of one of the proposed sites and no one would have to travel more than 20 miles to reach a Conservation Area. Three of the selected sites are in the North Sydenham Watershed and four are within the East Sydenham Watershed.

1. Duthill Conservation Area

This proposed site consists of 330 acres approximately six miles north of Wallaceburg on the North Sydenham River. It is the most westerly site recommended and was selected with "users" from the Wallaceburg area in mind.

A small tributary stream joins the Sydenham near the southern tip of the property. This site features three separate wooded areas. The remainder of the property is farm land devoted to field crops and pasture. At the western extreme of the site the river loops around an area of flood plain. Two separate farmyards each with home, barn and outbuildings are located very near the centre of the site.

A road goes through the middle of the site running roughly north and south. It gives easy access to all parts of the area. Parking can be conveniently provided at the very centre of the site.

The total area east of the road should be reforested. Subsequently nature trails, campsites and picnic areas could be developed in this section as demand indicates. South of the road a by-pass pool is suggested on the flood plain with adjacent picnic facilities. The wooded area to the south of the pool seems suited to the development of campsites. An extension of the southern entry road to serve such sites is indicated. A second area for campsite and service road is the wooded land at the north-west corner of the site.

The Sydenham gives access to Lake St. Clair and hence the complete St. Lawrence Waterways System. A boat-launching ramp is therefore recommended at the mid point of the site on the Sydenham River. Subsequently, provision may be made for boat storage and servicing immediately north and south of the launching area.

2. Avonry Conservation Area

This proposed site on Bear Creek consists of 183 acres. It is located one mile north-east of Avonry on the Moore-Sombra Township Line.

Access to the site is potentially good from north, south, east or west, but access roads require improvement.

The Duthill site features three wooded areas suitable for campsites, in addition to good river frontage along the flood plain.

The Petrolia Area is well-served with access roads and the flood plains are suitable for picnic areas and campsites.

Bear Creek enters the site at the north-east corner and follows the eastern boundary for three-quarters of its length and then turns at right-angles and flows west parallel to the southern boundary. Another right-angle turn occurs before it flows south and leaves the site at the south-west corner. Just before this last turn, the creek has cut across the base of a bend or loop thus shortening its passage. The township line road bends around this loop which is now a marsh.

While Bear Creek is bordered with quite thick scrub growth, the area to the north of the creek is agriculturally poor and would benefit from reforestation.

Without development the recreation potential of this site is limited. The development required, however, is not extensive. Planting is required throughout the area with a complete reforestation program recommended for the north half of the property. Bear Creek can be dammed just downstream from the loop and with five or six feet of excavation, the inside of the loop would flood creating a good pool for swimming. Picnic grounds could be established to the north and east of the pool and adequate parking space is available to the south of the township line road.

North of the creek, the eastern part of the area could be developed as campsites after planting has taken hold.

3. Petrolia Conservation Area

This site of 210 acres is perhaps the most attractive area recommended. It is located on Bear Creek 2 miles north-east of the town of Petrolia.

While running through the site from east to west, Bear Creek makes two full loops extending in both instances from near the northern boundary to near the southern boundary of the property. Thus four distinct flood plains are formed and north and south of the creek valley the banks rise steeply to a height of 25 to 40 feet.

At present, part of the flood plain land is being farmed and part is being used as pasture. Bear Creek is lined with mature trees pleasingly and irregularly spaced. Looking down from the bank, the valley at this point presents an attractive pastoral scene.

The Conservation Area is readily accessible by paved road. Highway 21 from Lake Erie to Georgian Bay forms the western boundary of the site and connects with highways leading to all the main centres of population in western Ontario; while a good gravel road runs through the southern edge of the property. There are several farm buildings located within the proposed boundaries including two farm homes on the northern bank of the valley.

It is suggested that Bear Creek be dammed at a convenient point near where it leaves the Conservation Area at its south-west boundary. While this would back the stream up for some two or three miles, the wide and level area of the flood plain would create a very shallow body of water. Some prior excavation is therefore necessary in order to create a pool of optimum depth. It is recommended that the flood plain between the southern loop of the creek and the farm service road be so excavated.

Tree planting is required throughout the area. Picnic grounds can be developed on both sides of the creek adjacent to the pool. Campsites are suggested in the north-east and south-west areas of the property. Precise locations of facilities will be dependent on the maximum limits of the proposed flooding. Parking can be

made available adjacent to the road at the eastern and western entries to the Conservation Area.

4. Alvinston Conservation Area

This area of 125 acres is located on Morragh Creek 2½ miles east of Alvinston very near the geographic centre of the Sydenham Watershed.

The site is accessible from the west by an improved gravel road and from the south-east by Highway No. 80. A farm service road enters the property from the north.

This site offers considerable variety of physical features. The hill is thickly wooded and covers the south-west portion of the area. The south-east portion of the area consists of farmed land, pasture and some scrub growth. The north-eastern quarter consists of low-grade agricultural land with some hawthorn growth. The north-west sector of the property is at present used as pasture and has some mature trees distributed unevenly along the creek. The north central area is a flood plain, at present used as pasture. There is a farm house and outbuilding, both in poor repair, on the brow of the hill.

The diversified topography of this area lends it great recreation potential. There is hill and plain, field and forest, and water. Unfortunately Morragh Creek does not supply a consistent flow of water and in the late summer tends to dry up. A dam, at a convenient location on the Sydenham, downstream from and close to where Moragh Creek enters the river, would provide an adequate water supply. The creek bed could be widened to form a pool adequate for swimming.

The north-east section of the site should be reforested and some tree plantings are recommended in the south-east section. Picnic grounds can be established on both sides of the proposed pool and to the west on both sides of the creek.

Parking facilities can be established just south of the existing farm buildings. The farm road should be extended south to serve campsites along the creek.

With an adequate water supply this can become a delightful recreation area. While no special provision is required, the slopes would provide excellent skiing for beginners when there is sufficient snow.

5. Coldstream Conservation Area

This proposed Conservation Area consists of 250 acres located on the East Sydenham River one mile north of Highway No. 22. It is approximately six miles north-east of the town of Strathroy and less than 13 miles from the city of London.

The site is bordered on the south by the hamlet of Coldstream and historic interest is added by the location of the Society of Friends Church on the north-eastern edge of the area. This church, still in fine repair, dates from the middle of the nineteenth century and is a good example of Quaker church architecture. The site is easily accessible by paved highway from all population centres in the district.

This area is less than ten miles downstream from the source of the East Sydenham. As a result, the water is quite shallow and the flow in late summer is quite low. The property is a long strip following the course of the river from north-east to south-west. The southern half of the area is quite narrow, about 200 yards in width, and is divided from the remainder by a concession road running from north-

west to south-east. At the southern tip is a nicely wooded area of about 8 acres. An unimproved road cuts across the site where the wooded area ends. From this point to the bisecting road the river sweeps in a broad curve, lined by trees and bush. Inside this curve is a low-lying area which in the past was flooded by a dam and provided a pond for a mill. Both the dam and the mill are no longer in existence. On the northern edge of this low area is the one-acre site of the Society of Friends church and churchyard which is 8 to 10 feet above the flood plain.

At the approximate centre of the area is a worked out gravel pit about 100 feet north of the river channel. This pit has been dug out of a good piece of agricultural land. The northern part of the site is covered with scrub growth but just to the south of this is a large well treed area of approximately 20 acres.

There are two possibilities for the improvement of water features in this area. First, a diversion from the river to the gravel pit could be cut thus creating a pond of greater depth. Second, a dam could be built which would provide a pond adjacent to the church site. Both ponds should be considered a long-range goal.

It is recommended that the wooded area to the south be left in its natural state and that nature trails be cut. Picnic areas are suggested around both of the proposed ponds. A campsite could suitably be located at the western edge of the large treed area. The scrub growth area should be reforested and proper forest conservation introduced to the total wooded area; it could then serve as a demonstration woodlot.

6. Oakdale Conservation Area

This site consists of 110 acres located on the East Sydenham River two miles east of Oakdale and three miles north of Florence. It is approximately 8 miles north-west of Bothwell. The property is in the Township of Dawn.

The bulk of the property is beautifully forested with a wide variety of trees. The greatest part of this forest lies north of a good gravel road running east and west which bisects the property. South of this road the land slopes to the river where there is a narrow flood plain about 100 yards wide which is at present used as pasture. The south-west and south-east corners of the area are being farmed. These two fields are divided by the southern extension of the forest.

The eastern border of the property is the Dawn-Euphemia town line road while the southern boundary is the river. Access to the area is quite easy via good gravel roads.

The central feature of this site is the fine woodlot. Good forest conservation practices for demonstration purposes and the cutting of nature trails is indicated. The small flood plain can accommodate a small diversionary pool, flanked by picnic facilities. The two farm fields referred to could be turfed, planted with shade trees and established as picnic areas. Adequate parking can be supplied at the eastern and western edges of the property adjacent to the road. The southern part of the forest could supply adequate campsites.

7. Dresden Conservation Area

This proposed Conservation Area is located at the junction of Long Creek and the East Sydenham River one mile east of Dresden. It consists of 175 acres in a long strip following the river and creek and the extension of Highway No. 78. The highway forms the northern boundary of the western portion of the area then cuts

The approach to the Dresden Conservation Area is functionally excellent and picturesque.

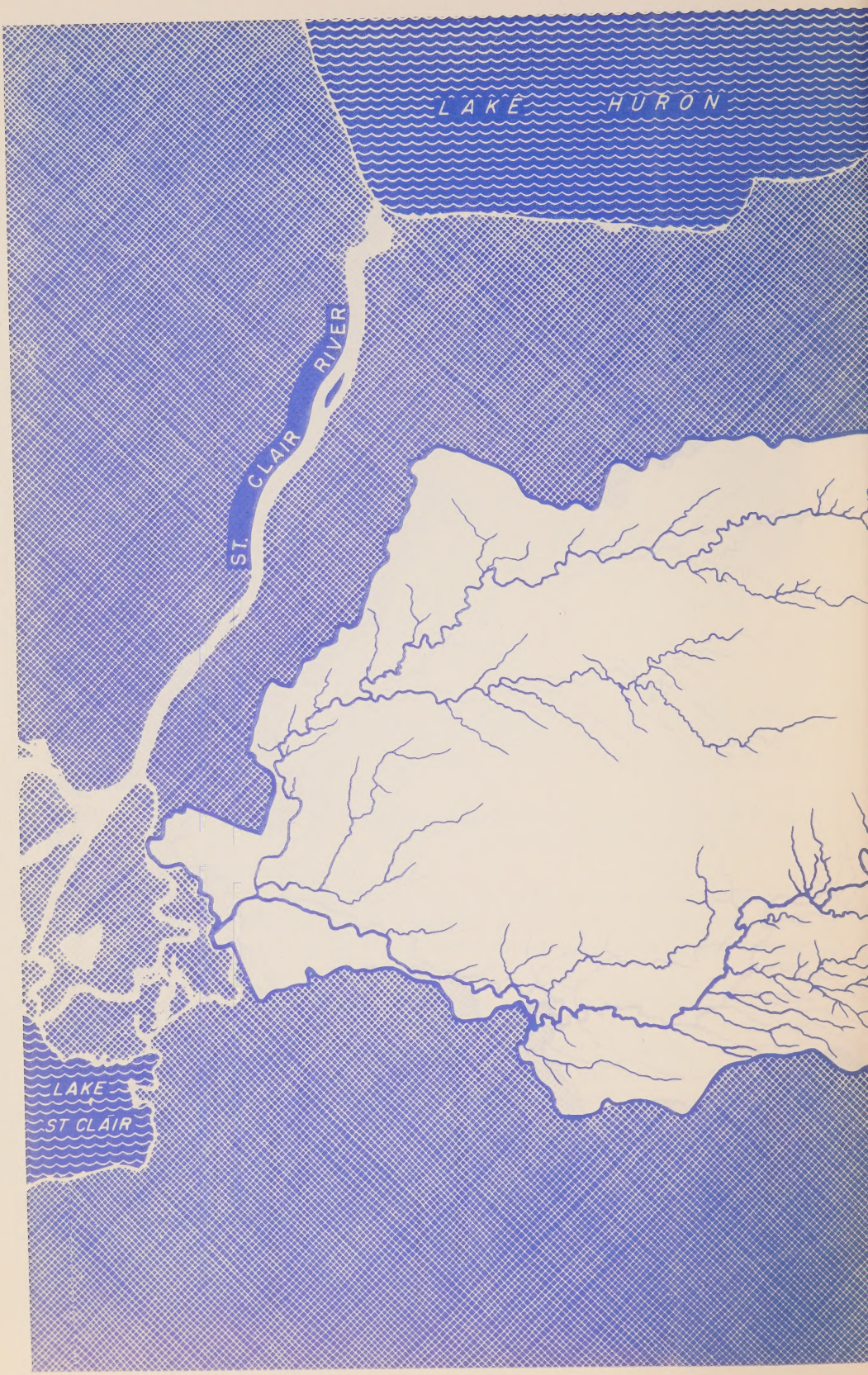
across the site and forms the southern boundary of the eastern portion. The eastern boundary is Concession road VI. The site comprises parts of Lots 5 and 6 in Concession V and Concession VI, Gore of Camden Township. Dresden Town Cemetery abuts the western edge of the area.

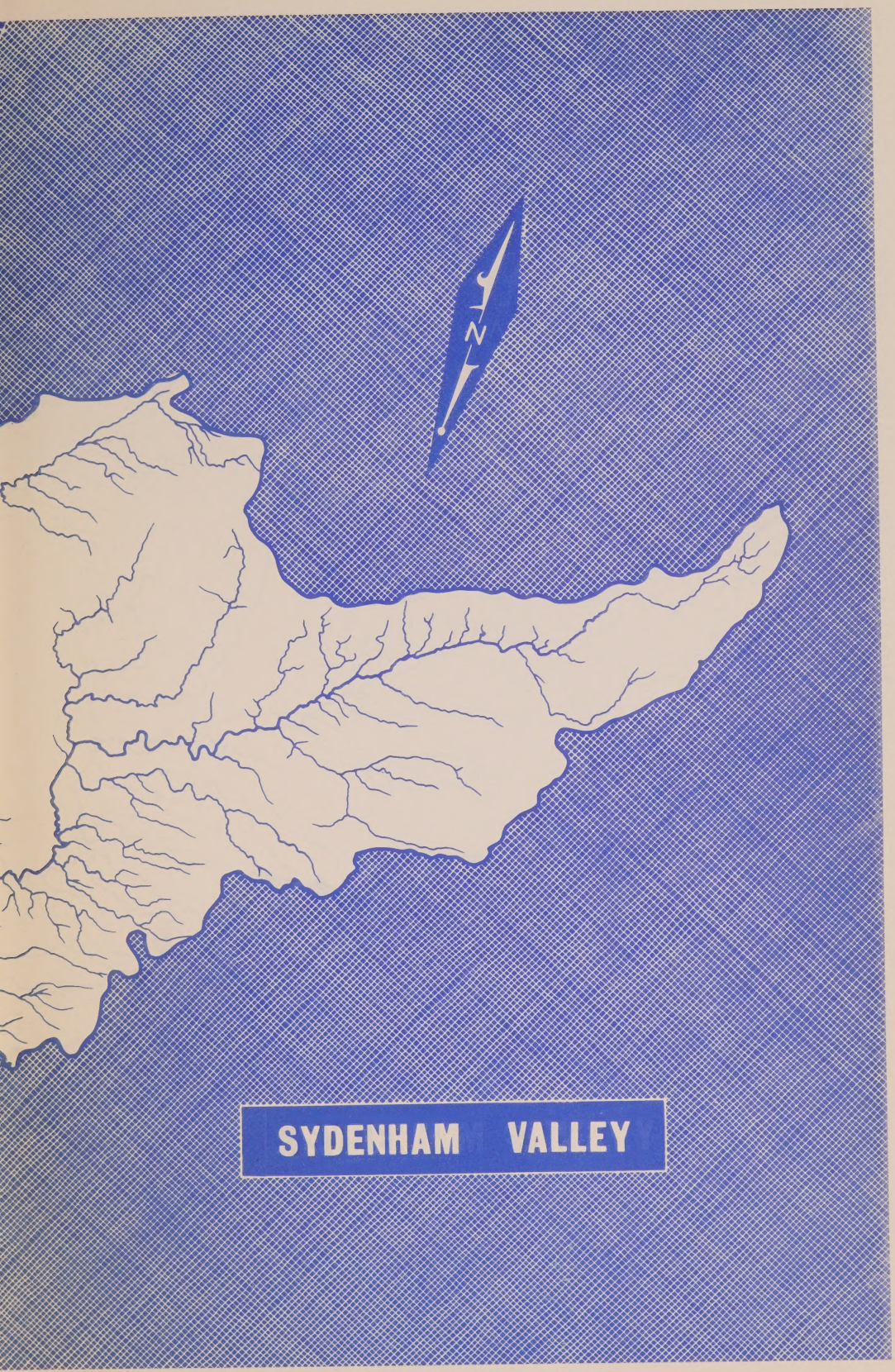
Accessibility is excellent. The site is just one mile east of the junction of Highway No. 21 and Highway No. 78. It is the only recommended site within 10 miles of the Town of Dresden.

The banks of the river and creek are well treed. The balance of the property is low-grade agricultural land with the exception of a 25-acre block of good farm land at the south-east corner of the site. A farm home and outbuildings are located just south of where the road bisects the site.

It is recommended that the river be diverted at a point immediately south of the farm house to form a by-pass pool. This would become the focal point for picnic sites south of the road. The area north of the road can be improved with considerable tree planting. At least one more picnic site can be located between Long Creek and the extension of Highway No. 78. A nature trail should be cut following the creek from the Sydenham to where it leaves the Conservation Area. Adequate parking can be provided north of the road to serve the eastern half of the property and south of the road to serve the western half.

The recommendations for development of these seven proposed Conservation Areas are intended to be general guides. More detailed and specific planning must be based on a more thorough study of each site and potential constituency.


LAKE HURON
ST. CLAIR RIVER
LAKE
ST CLAIR


N
SYDENHAM VALLEY